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AIR CUSHION VEHICLES - A BRIEFING

by John L. Anderson and Patrick M. Finnegan

Lewis Research Center
Cleveland, Ohio

October 1971

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AIR CUSHION VEHICLES - A BRIEFING

by John L. Anderson and Patrick M. Finnegan

INTRODUCTION

The air cushion vehicle (ACV) provides a step increase in surface mobility over any vehicle man has ever known. It needs no surface contact; it glides on a cushion of air over ocean, river, ice, snow, mud, sand, or any relatively flat surface. In 15 years the ACV has gone from a "table-top" demonstration to commercial vehicles carrying more than a million passengers each year. By the end of the century its mobility and speed could dramatically affect surface warfare, world trade, and the distribution of people on earth.

This brochure is a briefing on the ACV: experience and characteristics; the powering, uses, and implications of large ACV's; and the study of one particular use—the conceptual design and operation of a nuclear powered ACV freighter and supporting facilities.

FIGURE 1

The air cushion vehicle (ACV) has been called the fourth fundamental development in transportation since the beginning of civilization. Interestingly, it seems to be the only one of the four that has no analogy in nature.

FUNDAMENTAL DEVELOPMENTS IN TRANSPORTATION

	NATURAL ANALOG
WATERCRAFT	— FLOATING LOG
• WHEELED VEHICLE	— ROLLING STONE
• AIRCRAFT (AERODYNAMIC)	— BIRD IN FLIGHT
AIR CUSHION VEHICLE (AEROSTATIC)	— FOREIGN TO NATURE

Figure 1

FIGURE 2

The ACV can travel over special rails or tracks, concrete roads, grassy plains, sandy beaches and deserts, mud flats, swamps, rice paddies, snowfields, Arctic ice floes, the high seas, and ice-choked or white-water rivers. In short, with the exception of significant obstructions and depressions, the ACV is surface independent.

ACV OPERATING ON VARIOUS SURFACES

(Courtesy Bell Aerospace Company)

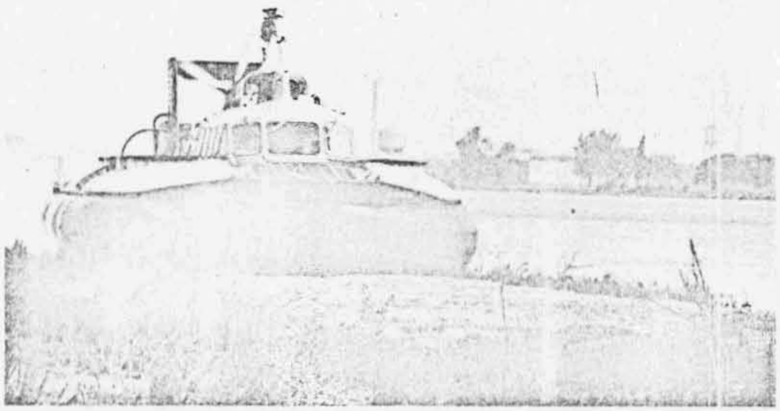

Figure 2(a)

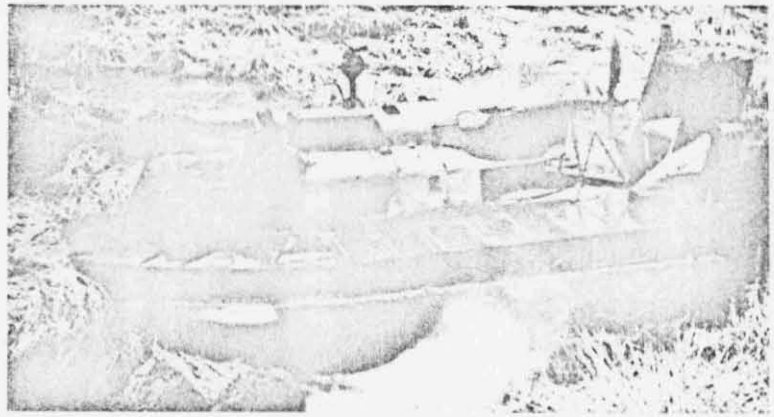

Figure 2(b)

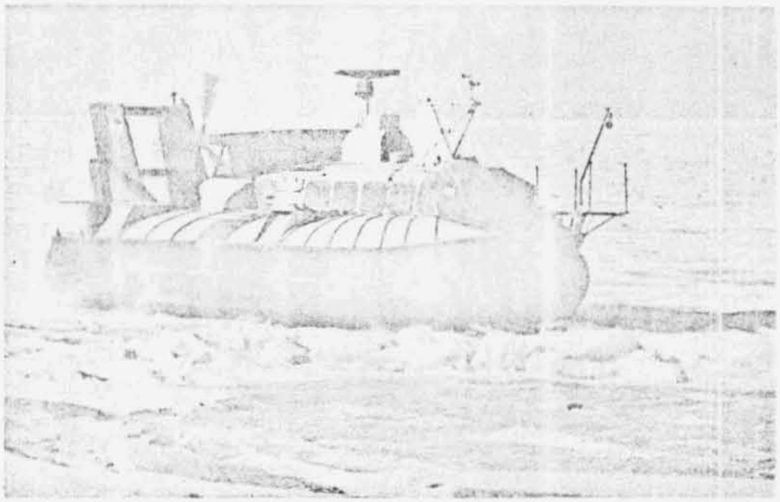

Figure 2(c)

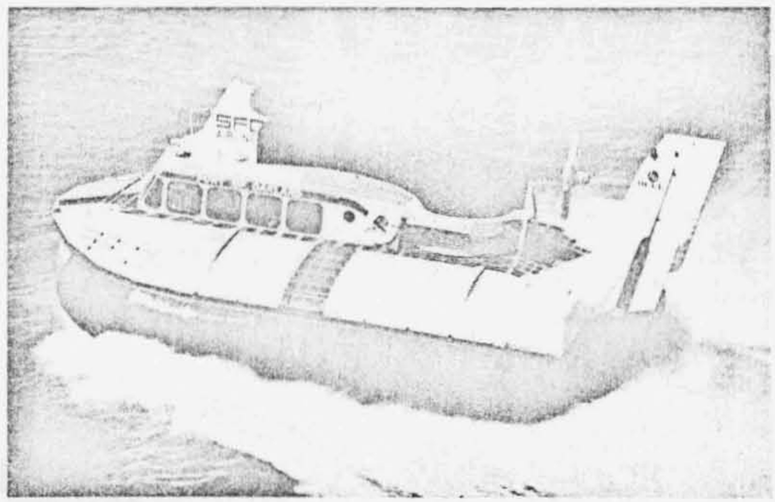

Figure 2(d)

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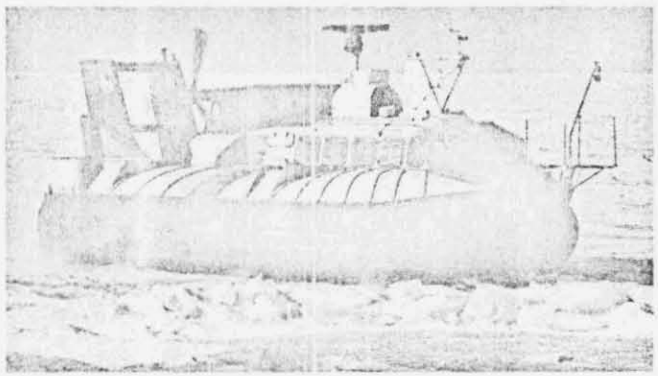
FIGURE 3

Since 1956 this fundamental, new form of surface transportation has, successively, been demonstrated on a small scale, carried a man, been put into commercial service, logged several million miles, and carried a few million passengers. This vehicle is known as a Hovercraft in Britain, where it has been developed. In the U.S. and Canada it is generally called an air cushion vehicle. It has even been described as a magic carpet in an attempt to indicate the potential of this vehicle that rides on a cushion of air free from surface contact. The names containing surface effect or ground effect unfortunately imply to people who have worked on aircraft design an aerodynamic effect obtained by flying an aircraft close to the ground.

VARIOUS NAMES FOR THE SAME CONCEPT



- HOVERCRAFT
- AIR CUSHION VEHICLE . . . . ACV
- SURFACE EFFECT VEHICLE . . SEV
- GROUND EFFECT MACHINE . . GEM

Figure 3

FIGURE 4(a)

On the contrary, the true air cushion vehicle uses an aerostatic effect. The air cushion vehicle or ACV operates by forming a pressurized cushion of air under it. Using lift fans the air is pulled into the craft, forced into a plenum, and then directed under the craft from the periphery. The air escapes from around the craft and forms an annular air gap which separates the ACV from the surface.

ACV PERIPHERAL JET-FLEXIBLE SKIRT PRINCIPLE

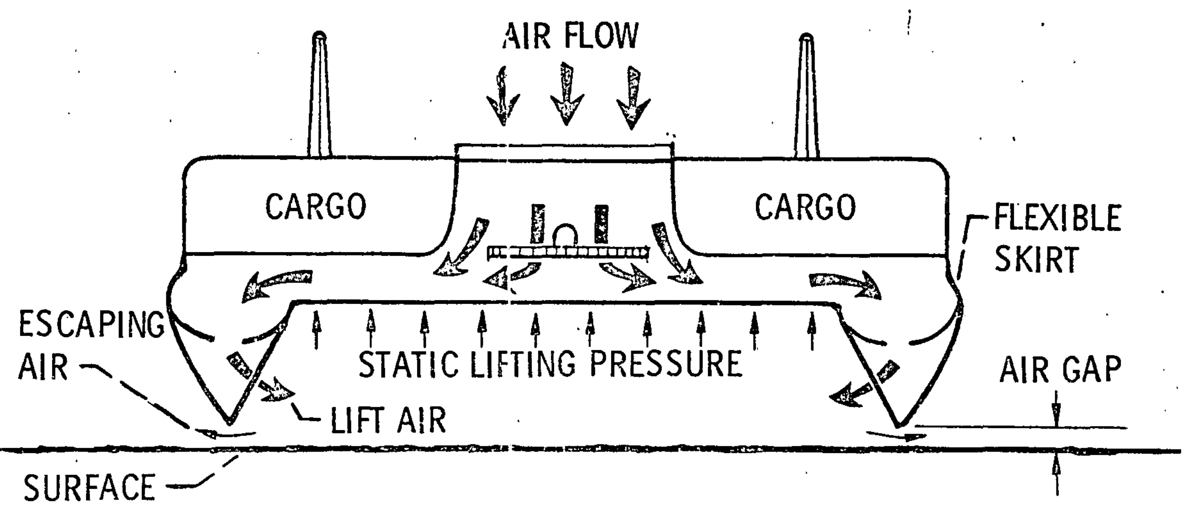


Figure 4(a)

FIGURE 4(b)

The peripheral jet of air is directed by a flexible skirt consisting of a rubber inner-tube-like bag with air flow channels called "fingers" attached. The skirt serves as a shock absorber during impact with waves or low-lying solid objects. The finger arrangement permits replacement of selected portions of the skirt that are worn or damaged.

PORTION OF FLEXIBLE SKIRT AND AIRFLOW

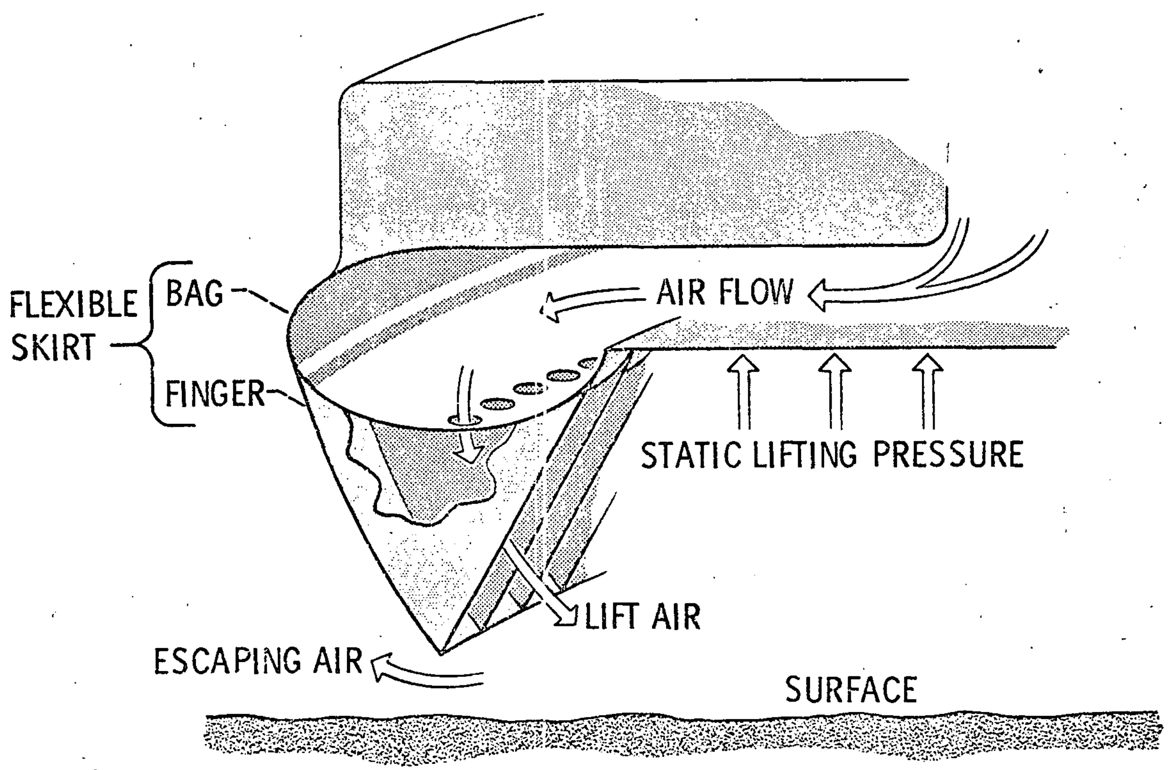


Figure 4(b)

FIGURE 4(c)

The peripheral jet air cushion concept allows complete freedom from surface contact. Furthermore, to lift a vehicle or load free from the surface with an air cushion requires surprisingly little power. An interesting illustration is that a Volkswagen on an air pallet about equal to its planform area can be lifted by a household vacuum cleaner motor.

TRANSPORTER AIR PALLET FLOATS 1800 POUND AUTO ON FILM OF AIR. AIR SOURCE - A SINGLE HOUSEHOLD TYPE VACUUM CLEANER.

(Courtesy Aero-Go, Inc.)

Reproduced from best available copy.

Figure 4(c)

FIGURE 5

There are a number of novel features of a vehicle that floats on a cushion of air. For example, because the vehicle or load is supported by a cushion covering most of the planform area, the resulting pressure on the supporting surface is quite low. This would be an advantage for a vehicle based in northern Canada where tundra erosion dictates surface pressures of less than 1 pound per square inch. The low surface pressure of the ACV also means that any surface over which it travels will require little or no preparation. Furthermore, it should be ecologically significant that a man would leave a deeper track than an ACV.

SURFACE TRANSPORT VEHICLES

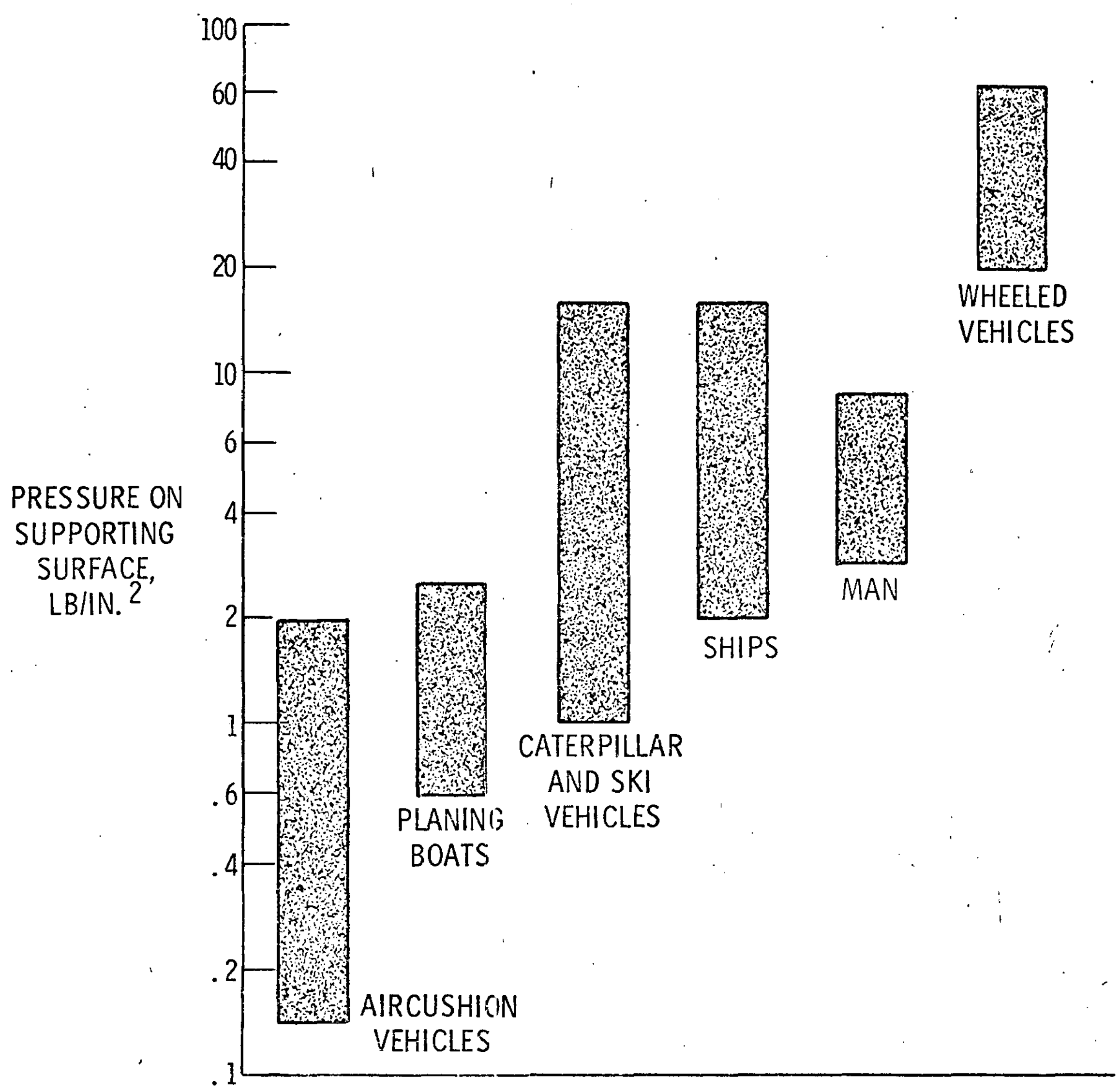


Figure 5

FIGURE 6

Also because of its flexible skirt, which contains the air cushion, the ACV can cross solid obstacles as high as 85% of the skirt height. It can plough over waves that are actually higher than the skirt. Depending on its speed and orientation, it can cross deep gulleys whose width is nearly 1/3 the length of the ACV; it can cross much wider gulleys that are not so deep. (The critical factors are how much air is lost from the cushion and how quickly the lift fans can replenish it.) It can negotiate slopes of a few degrees. Thus, the terrain can not only be unprepared, but it can also be quite rough and still not significantly hinder an ACV.

OBSTACLE AND DEPRESSION TOLERANCES

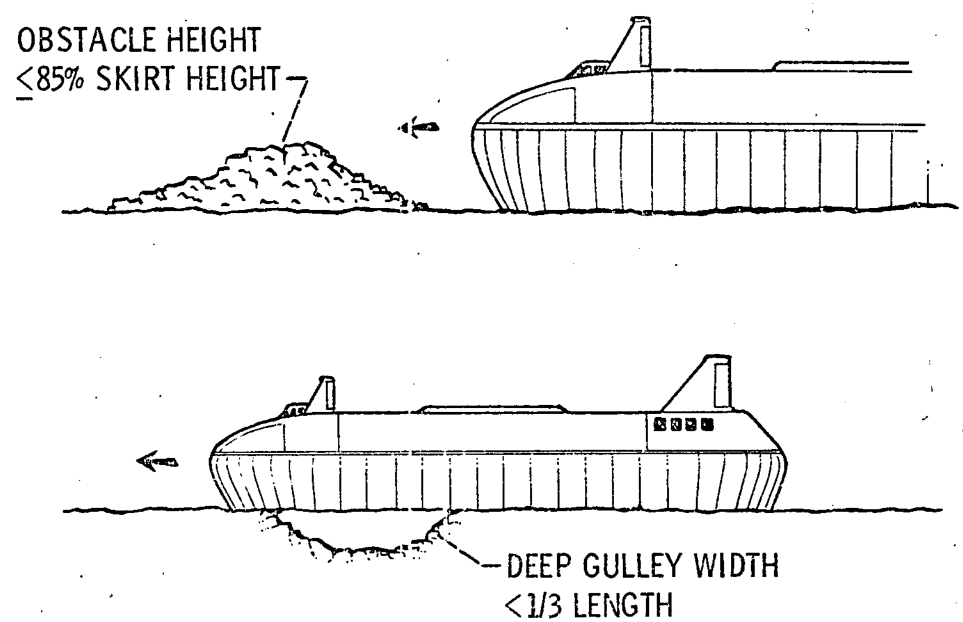


Figure 6

FIGURE 7

In the ACV several novel features are incorporated into one vehicle and the effects of these features are thus compounded. This has given the ACV such unusual mobility that it is truly a multiphibian. Many rivers, lakes, oceans, deserts, grasslands, tundra, and other flatlands of the world now become a global "superhighway" system for ACV's.

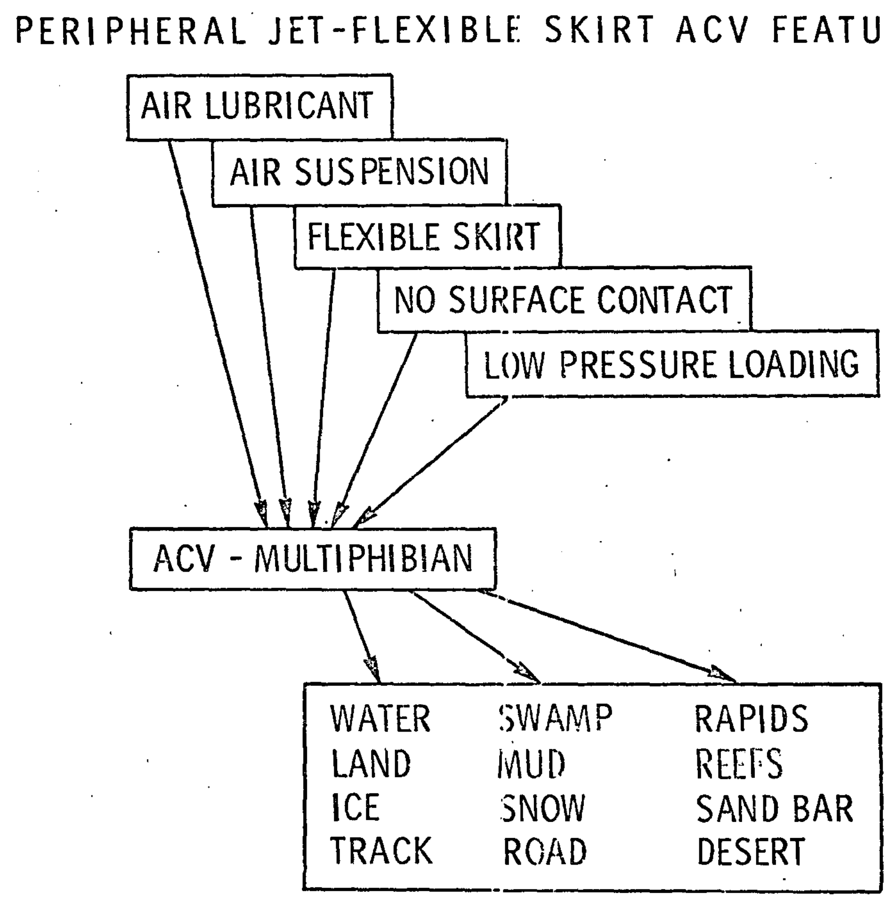


Figure 7

FIGURE 8

The peripheral-jet - flexible-skirt principle is an example of the true ACV - it is completely free of surface contact and can travel over water and land. One hybrid ACV replaces the flexible skirt on the sides of the vehicle with rigid walls. (But the fore and aft sections are still "flexible.") These rigid sidewalls extend into the water and prevent air escape from the sides of the craft. Hence, this is called the captured air bubble (CAB) principle. (In the U. S. this rigid sidewall or CAB craft is called a surface effect ship (SES).) The CAB principle requires less lift power than the peripheral-jet - flexible-skirt principle, but the drag is increased and an even harsher penalty is imposed - the CAB craft is restricted to water. Accordingly, the implications and potential of the pure, surface-free ACV's are the basis for this briefing.

ACV-CAPTURED AIR BUBBLE PRINCIPLE

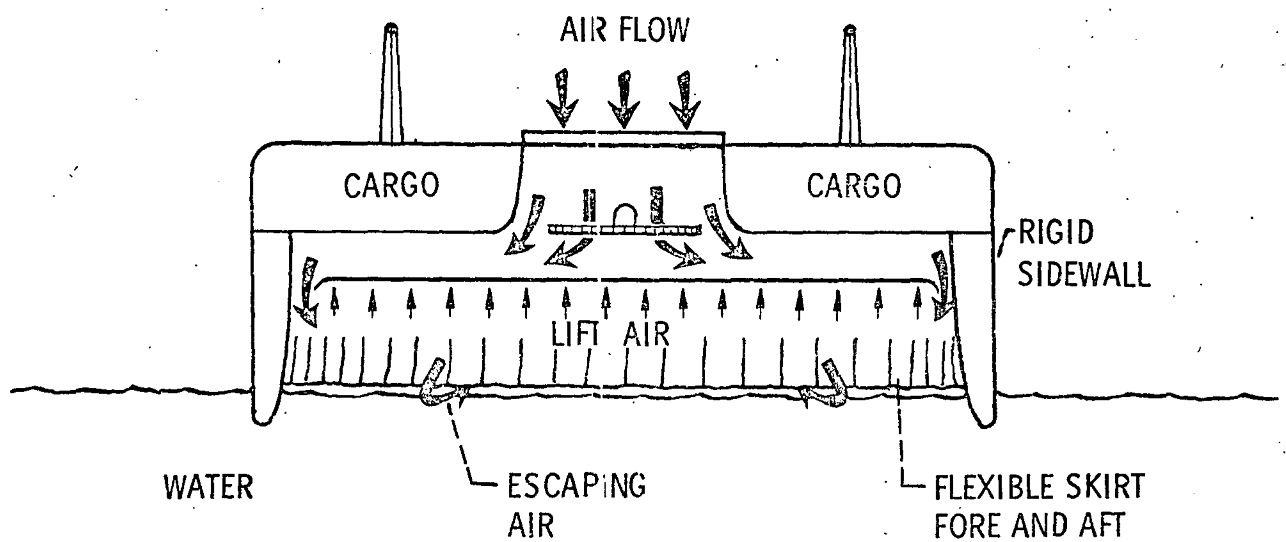


Figure 8

FIGURE 9

The ACV has been developed at an impressive rate. It took only 3 years from the "table-top" demonstration of the air cushion principle in 1956 to the practical demonstration of a man-carrying vehicle (across the English Channel!). It took only 3 more years for the ACV to be put into commercial ferry service (elsewhere in England). Hovercraft ferry service across the English Channel began in late 1968. And during 1971 well over 1 million people and 100 000 cars are expected to cross the English Channel by Hovercraft.

AIR CUSHION VEHICLE MILESTONES

1956	PRINCIPLE DEMONSTRATED
1959	MAN-CARRYING VEHICLE DEMONSTRATED (ACROSS ENGLISH CHANNEL)
1962	ENTERED COMMERCIAL SERVICE
1966	ENTERED SERVICE IN VIETNAM
1968	COMMERCIAL SERVICE ACROSS ENGLISH CHANNEL
1971	WILL CARRY MORE THAN 1 MILLION PASSENGERS

Figure 9

FIGURE 10

Until recently the largest Hovercraft in the world were four 168-ton SR N4's. (In 1971 a 250-ton Arctic oil transporter was demonstrated.) The SR N4 can cruise at 65 knots carrying 254 passengers and 30 cars; it began ferry service across the English Channel in 1968. Since then SR N4's have doubled their cross-channel traffic each year. In 1970 four SR N4's carried 844 000 passengers and 120 000 cars cross-channel with a total service reliability of 95%. In another region of Britain, the Solent, 10-ton SR N6 craft have a service reliability greater than 99% including cancellations due to bad weather. Thus chemically-powered ACV's (up to a few hundred tons) appear to be both technically and economically practical.

BRITISH HOVERCRAFT LTD. SRN-4 AIR CUSHION VEHICLE

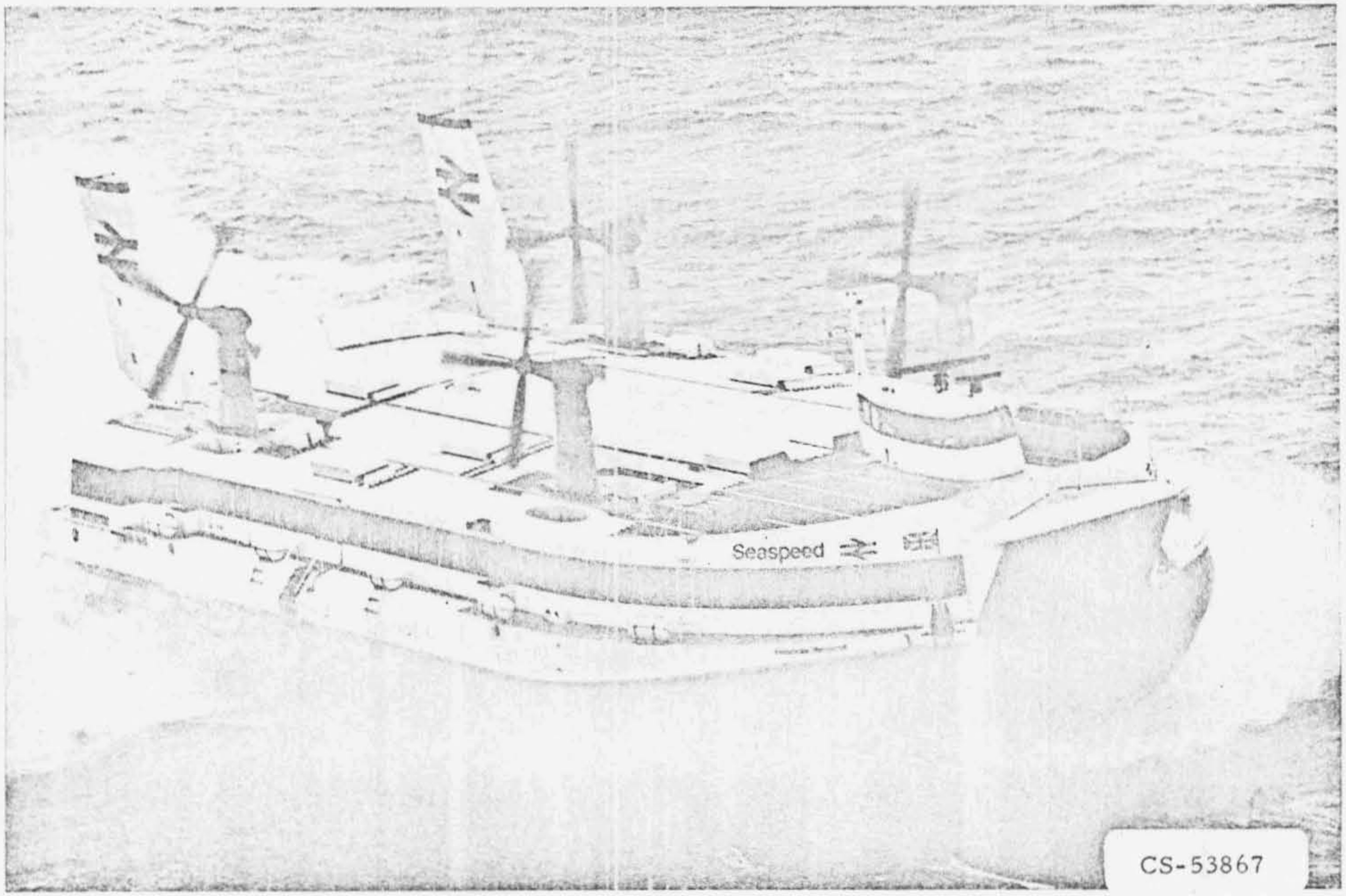


Figure 10

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FIGURE 11

The bulk of the work in the U.S. has been conducted by JSESPO, the Joint Surface Effect Ship Program Office (joint between Dept. of Commerce and the U.S. Navy). Through parallel contracts to Bell Aerosystems and Aerojet General, two separately designed 100-ton vehicles are to begin their sea trials in 1971. The Bell surface effect ship shown uses the captured air bubble principle, which requires contact with the water. This vehicle is a prototype of larger chemically powered surface effect ships - in the 4000- to 5000-ton class - for the mid-70's. Furthermore, two military development programs now in their beginning phases are the amphibious assault landing craft for the Navy and an Arctic-based vehicle for ARPA—the Advanced Research Projects Agency.

BELL AEROSYSTEM SURFACE EFFECT SHIP

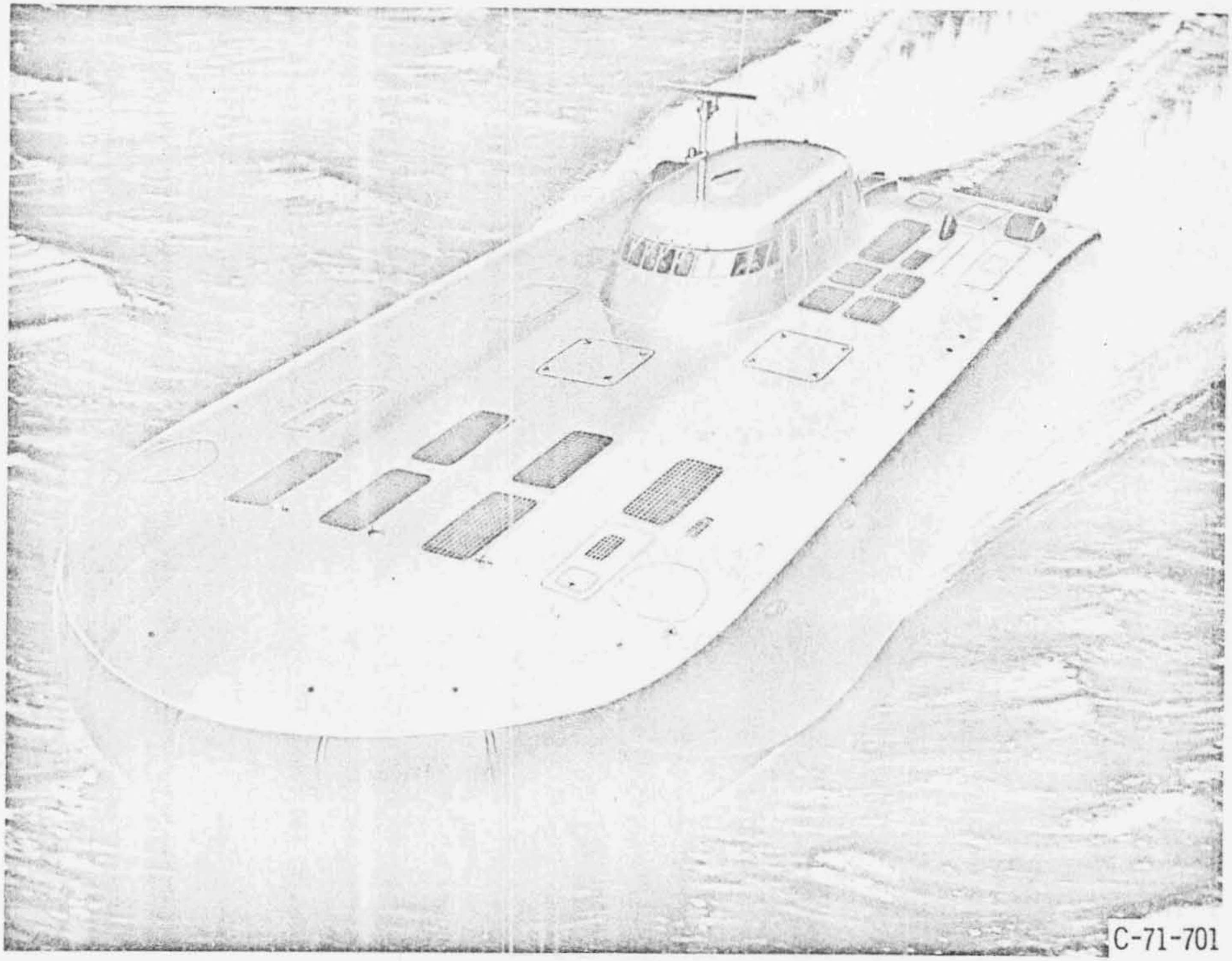

Figure 11

FIGURE 12

Given the success of the ACV to date, what can be said for much larger ACV's - up to several thousand tons? For an ACV the gross weight is supported by the area of the cushion, which is about the planform area of the vehicle. However, the air loss, and hence the power needed, is proportional only to the perimeter of the vehicle (which goes roughly as the square root of the area). The clearance height above the surface (daylight gap) may be kept constant. Thus the specific power required by an ACV decreases as the gross weight increases. The larger the ACV, the smaller the horsepower per ton needed.

SPLIT VIEW OF ACV SHOWING GROSS WEIGHT AND POWER DEPENDENCE ON SIZE

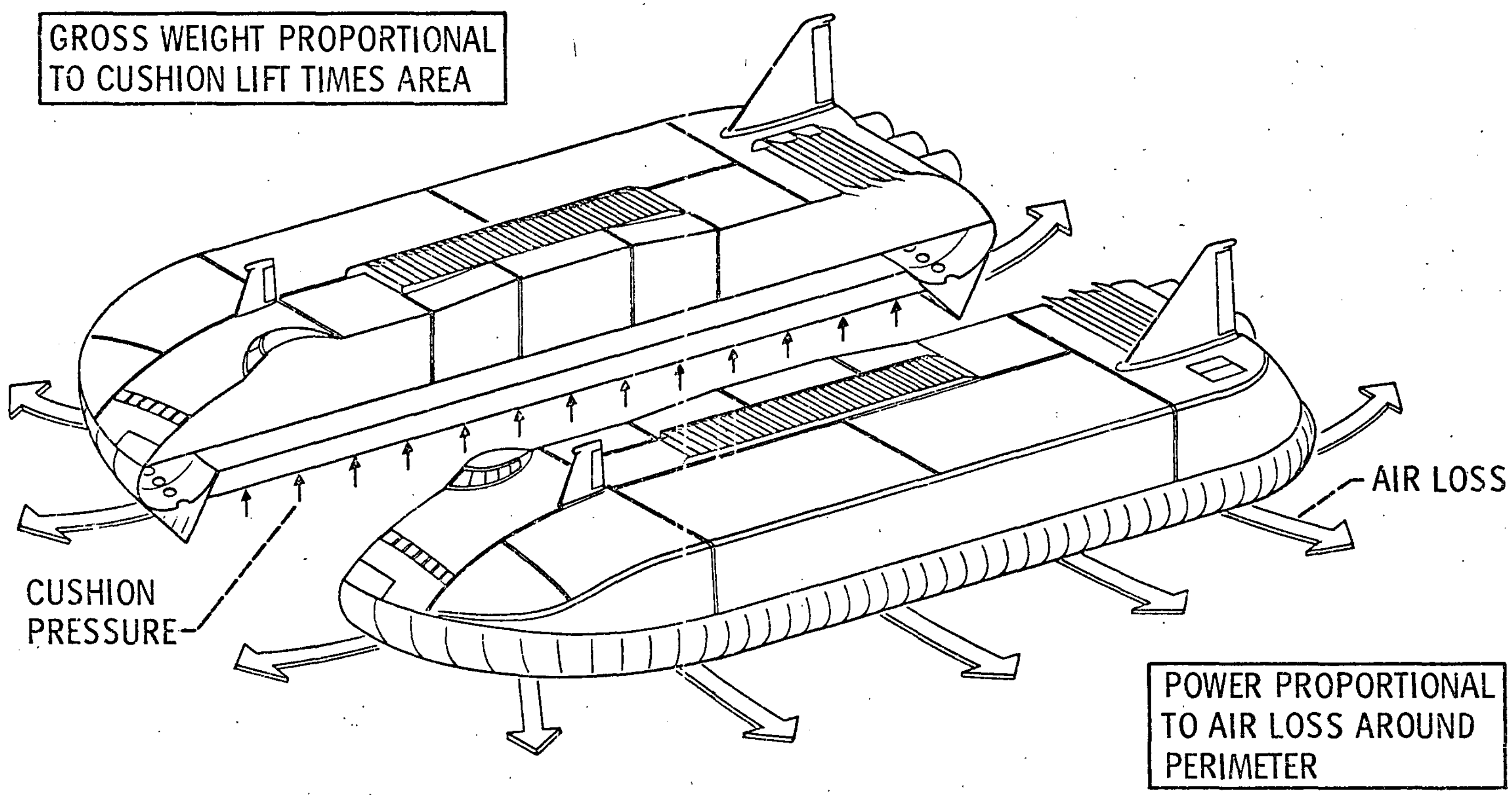

Figure 12

FIGURE 13

Most of the studies of large ACV's have been for military use, particularly the U. S. Navy. Small ACV's (about 5 tons) have already been used by the Navy in Vietnam; the much larger (160-ton) assault landing craft is under development. The concept of the "100-Knot Navy" now exists with ACV's being considered for antisubmarine warfare, assault landings, logistics transport, and even aircraft carriers. On the civilian side, studies of large cargo-carrying surface effect ships have been supported by the Maritime Administration. It is the use of large ACV's as ocean-going freighters that will be further discussed here.

ACV APPLICATION

(Courtesy Bell Aerospace Company)

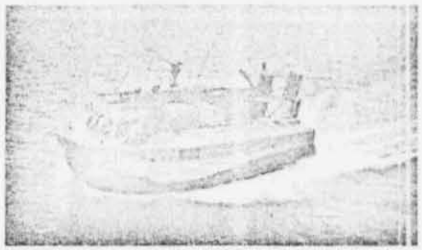

Figure 13(a)

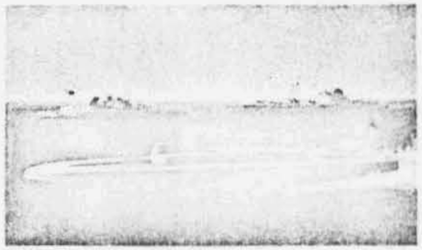

Figure 13(b)

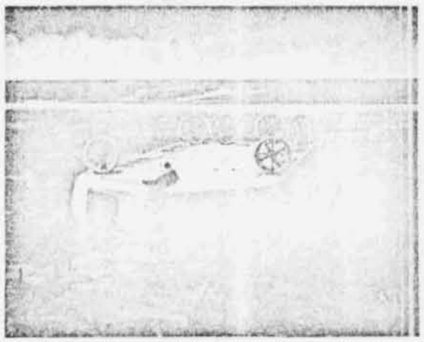

Figure 13(c)

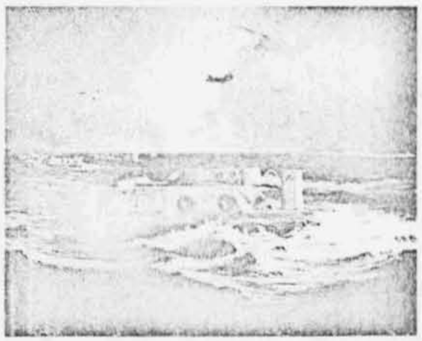

Figure 13(d)

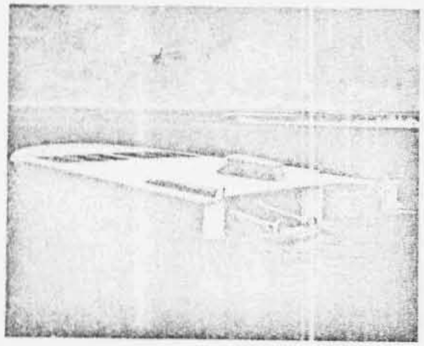

Figure 13(e)

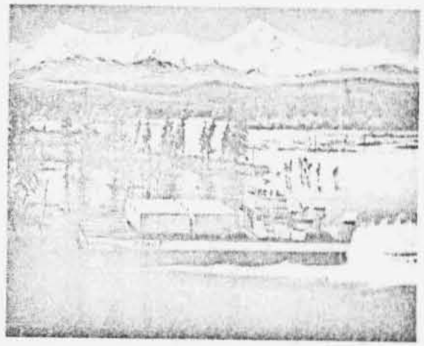

Figure 13(f)

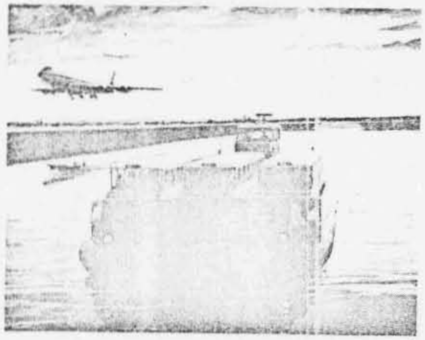

Figure 13(g)

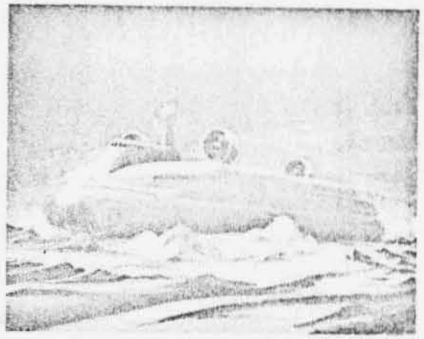

Figure 13(h)

FIGURE 14

There is presently a carrier gap in overseas transportation. Bulk and dry cargo can be carried by conventional ships at low speed and low cost - less than 20 knots and 5 cents per ton-mile. At the other extreme high value cargo is carried by aircraft at speeds greater than 200 knots but costs greater than 19 cents per ton-mile. (In spite of the higher price a growing percentage of transocean cargo is going by air.) But there is no carrier at intermediate speed and cost. Simplified economic studies indicate that chemically powered ACV's in the multithousand ton class could be economically competitive as a carrier on transatlantic routes. Studies also show that, using lightweight nuclear reactor technology considered for the nuclear airplane, a nuclear powered ACV could be even more competitive, especially for the longer ranges. Thus, it appears that an ACV in the 4000- to 10 000-ton class could fill this carrier gap as an intermediate speed (100 knots), intermediate (perhaps even low - 1 to 2 cents per ton-mile) cost vehicle.

CARRIER GAP IN OVERSEAS TRANSPORTATION

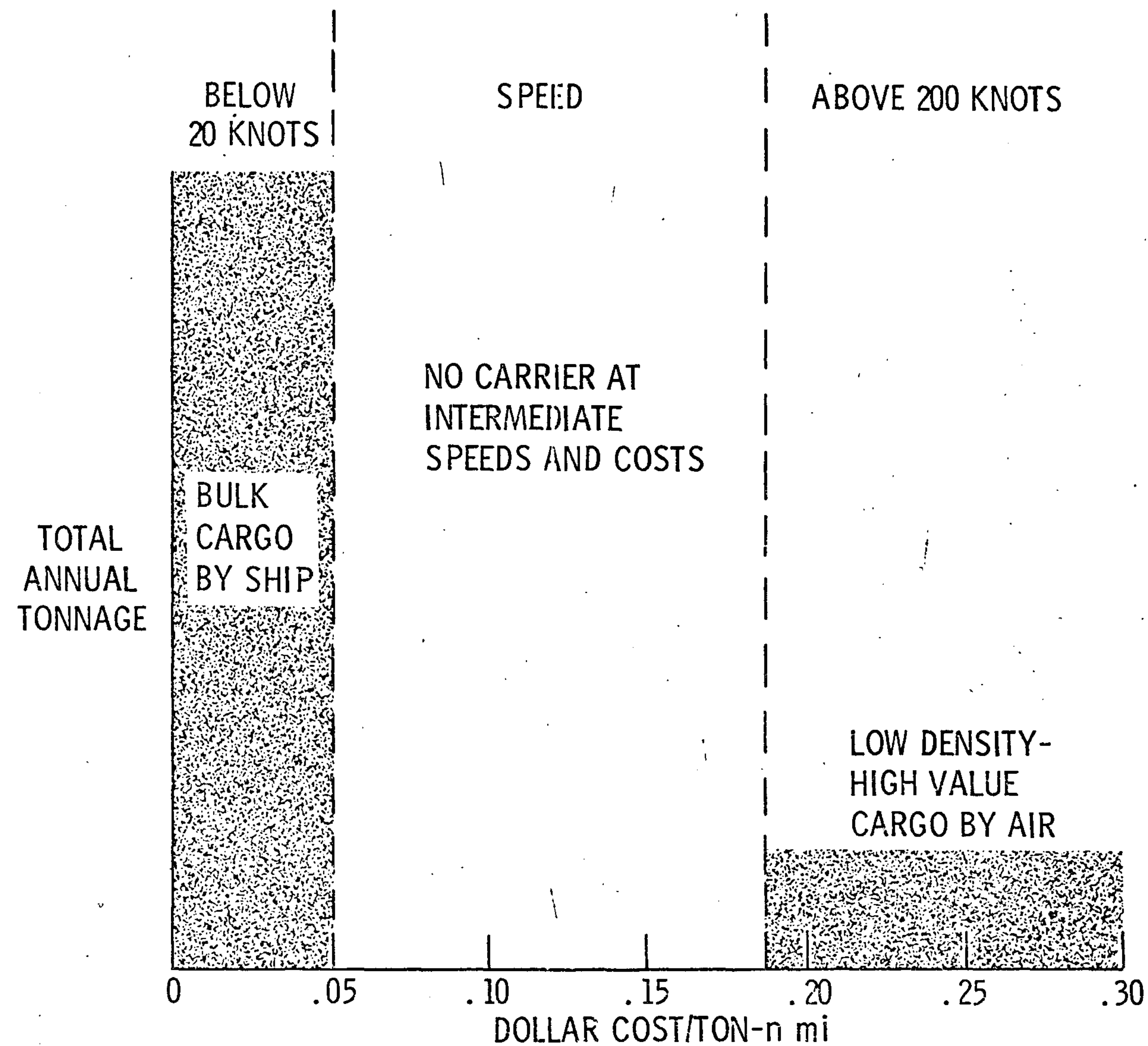

Figure 14

FIGURE 15

By the 1980's, when large ACV's could become available on a production basis, the world dry cargo trade will have risen by 50% - to about 1.3 billion tons. At present the U.S. flag fleet carries only 7% of our <u>own</u> dry cargo trade, which is about 1/3 of the world trade. There will clearly be an increasing need for more cargo vehicles. It is estimated that more than 250 5000-ton ACV freighters (payload fraction about 1/2) would be needed in 1980 to carry just 5% of the world's dry cargo ocean trade.

OCEANBORNE TRADE FORECAST

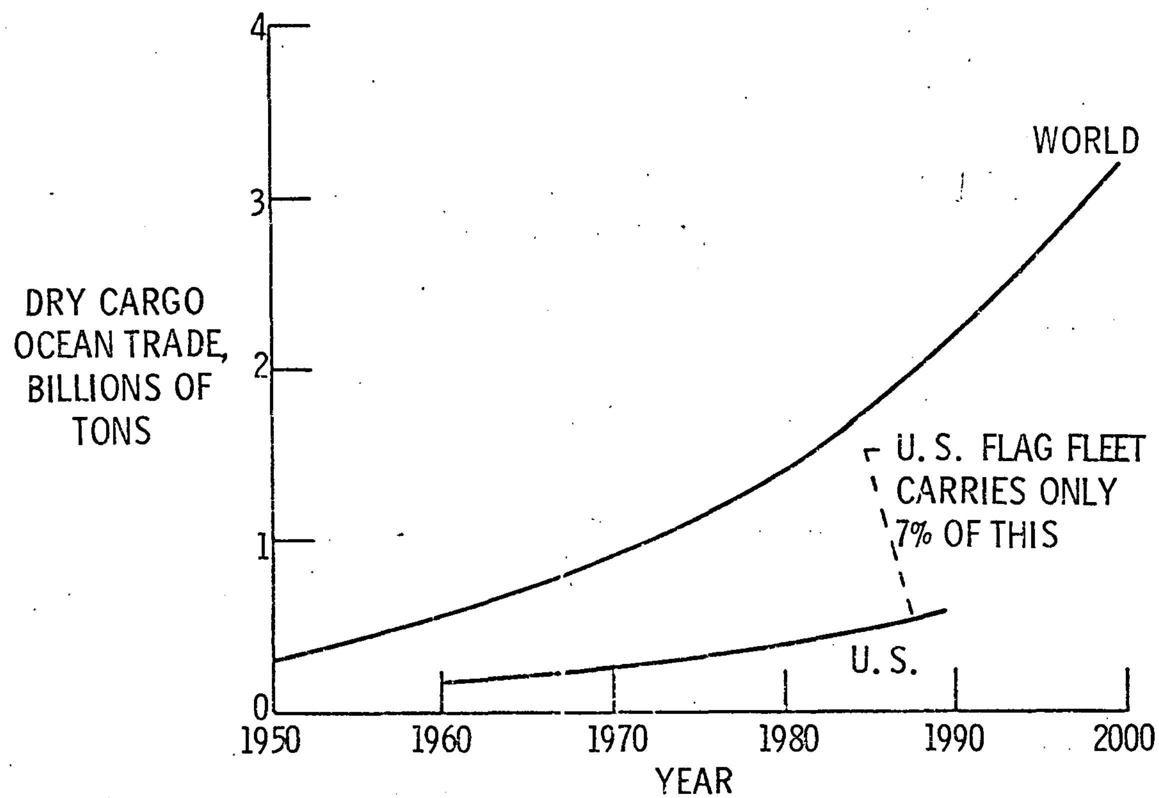

Figure 15

FIGURE 16

But now a question. How should large ACV's be powered - with chemical or nuclear fuel? Chemical power has the advantage of being nearly available, having been developed for use in aircraft and having been used on all (smaller) ACV's to date. But unless powerplant efficiency is improved, a chemical ACV of transatlantic (or greater) range may not be practical. Nuclear power would offer unlimited range and, as the range increases, an increasingly greater payload capacity for a nuclear ACV than for a chemical ACV of the same gross weight and range. But mobile nuclear powerplants presently are much too heavy. And there is also the problem of safety and public acceptance. Thus mobile chemical powerplants already exist that, with improved efficiency, would be adequate for many uses of ACV's. But sufficiently lightweight and publicly acceptable mobile nuclear powerplants will be needed for ACV's to have high payload and long (transocean) range.

MOBILE POWERPLANTS

	CHEMICAL	NUCLEAR
STATE-OF-THE-ART	AIRCRAFT EXPERIENCE USED ON SMALL ACV'S	NUCLEAR AIRPLANE STUDIES ("PAPER" STUDIES ONLY)
DEVELOPMENT GOALS FOR POWER SYSTEMS	BETTER EFFICIENCY	LIGHT WEIGHT SAFETY
APPRAISAL	COULD SOON BE AVAILABLE; MAY LIMIT LARGE ACV POTENTIAL	NEEDS TOTAL DEVELOPMENT; PUBLIC ACCEPTANCE A PROBLEM; ALLOWS FULL EXPLOITATION OF LARGE ACV POTENTIAL

Figure 16

FIGURE 17

The study of the nuclear airplane has required the study (thus far mostly on paper) of a lightweight nuclear powerplant technology. If this technology is applied to larger air cushion vehicles, then for ranges beyond about 2000 miles a nuclear ACV carries more payload than a "current-technology" chemical ACV of the same gross weight. The difference between the two increases as the range increases so that at a transatlantic distance (3500 n. mi.) the nuclear ACV has twice the payload of the chemical ACV. At a transpacific distance (6000 n. mi.) the nuclear ACV payload is four times the chemical ACV payload. Of course, the reason for this is that the chemical ACV has a substantial fuel weight consumption, whereas the nuclear ACV has essentially zero fuel weight consumption. (The available studies of chemical ACV's use current-technology chemical powerplants. But advanced high efficiency chemical powerplants would clearly improve the future chemical ACV performance.)

PAYLOAD FOR 10 000 TON ACV

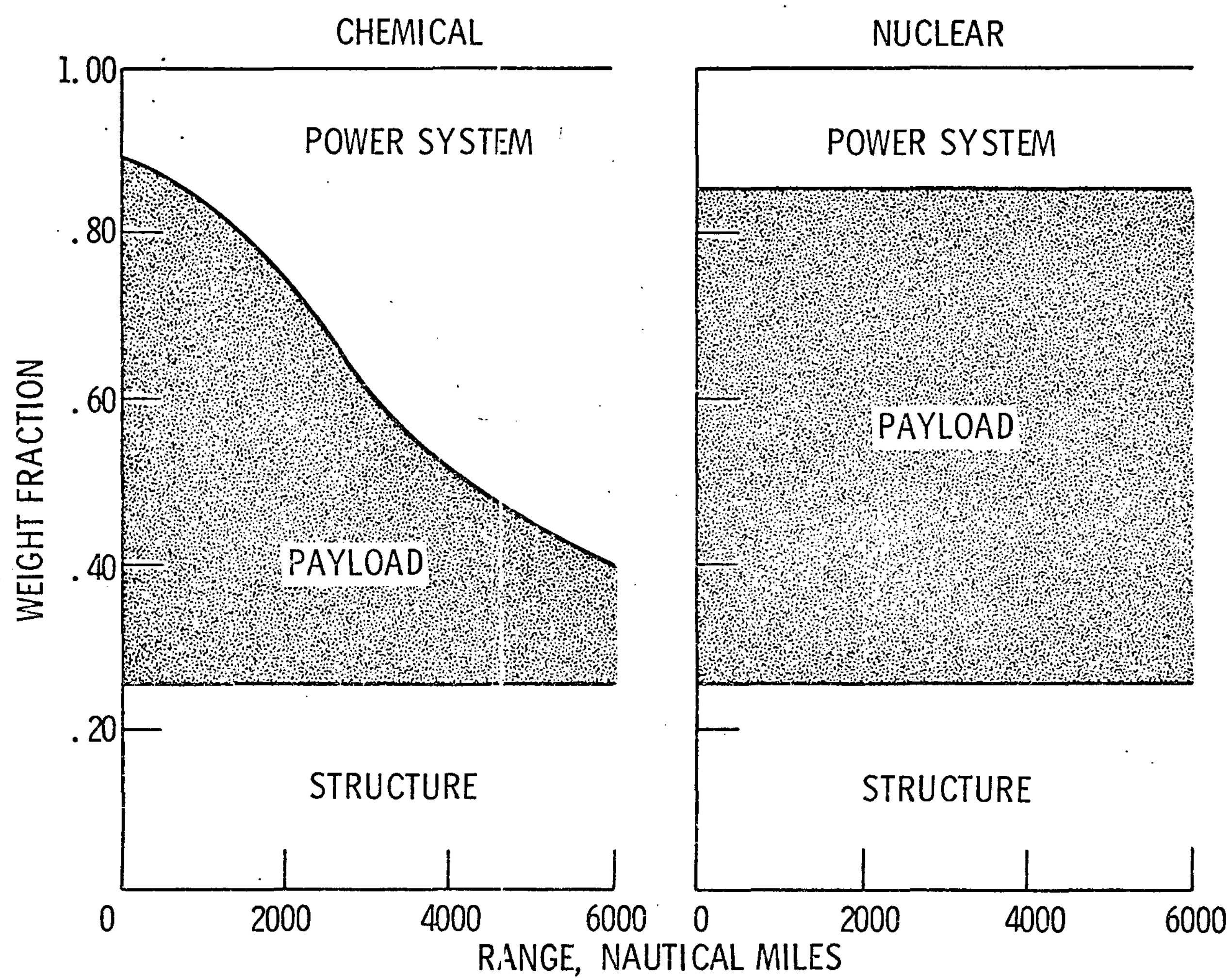

Figure 17

FIGURE 18

Directly related to the payload is the direct operating cost of ACV's. This cost is strongly dependent on range if they are chemical powered and nearly independent of range if nuclear powered. From simplified economic studies the potential advantage of nuclear ACV's over chemical ACV's at transoceanic ranges is clear. But certainly, this does not eliminate chemical ACV's from consideration as transocean carriers. And for shorter ranges, such as coastal routes around the continents, chemical ACV's are likely to be better.

OPERATING COSTS FOR NUCLEAR AND CHEMICAL ACVS

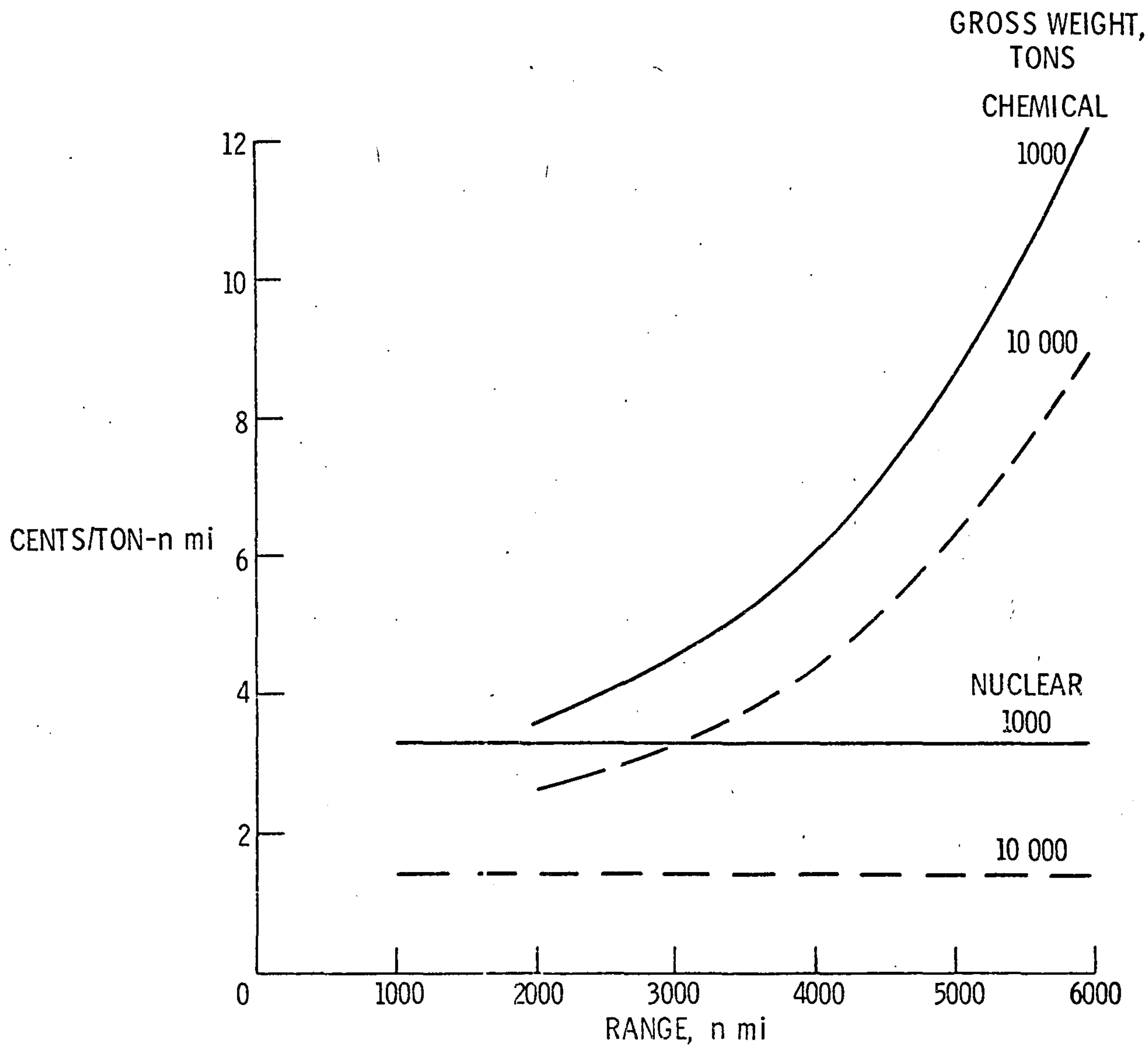

Figure 18

FIGURE 19

By the 1980's a marriage of two technologies - air cushion vehicles and mobile power-plants (efficient chemical ones or lightweight nuclear ones) - could dramatically affect transocean commerce. The new silhouette of air cushion freighters would appear on the oceans - and flatlands - of the world. One such nuclear freighter has been conceptually designed. This freighter could cross the Atlantic in 36 hours through 8-foot waves with 2700 tons of cargo; it could be unloaded, loaded, serviced, and underway again within 12 hours. This freighter could use any of the major deep water ports in the world, in much the same way as ships now do. But to repeat, it would be free of surface contact. Therefore, it would not be limited to deep water ports or to any water-bound ports at all. It could cross solid obstacles up to 18 feet high and deep gulleys as much as 150 feet across. It could continue over any relatively flat terrain to inland landlocked ports. Thus, much of the undeveloped coastland and river banks of the U.S. and even the world would become geographically capable of being an ACV port.

4500 METRIC TON NUCLEAR ACV FREIGHTER

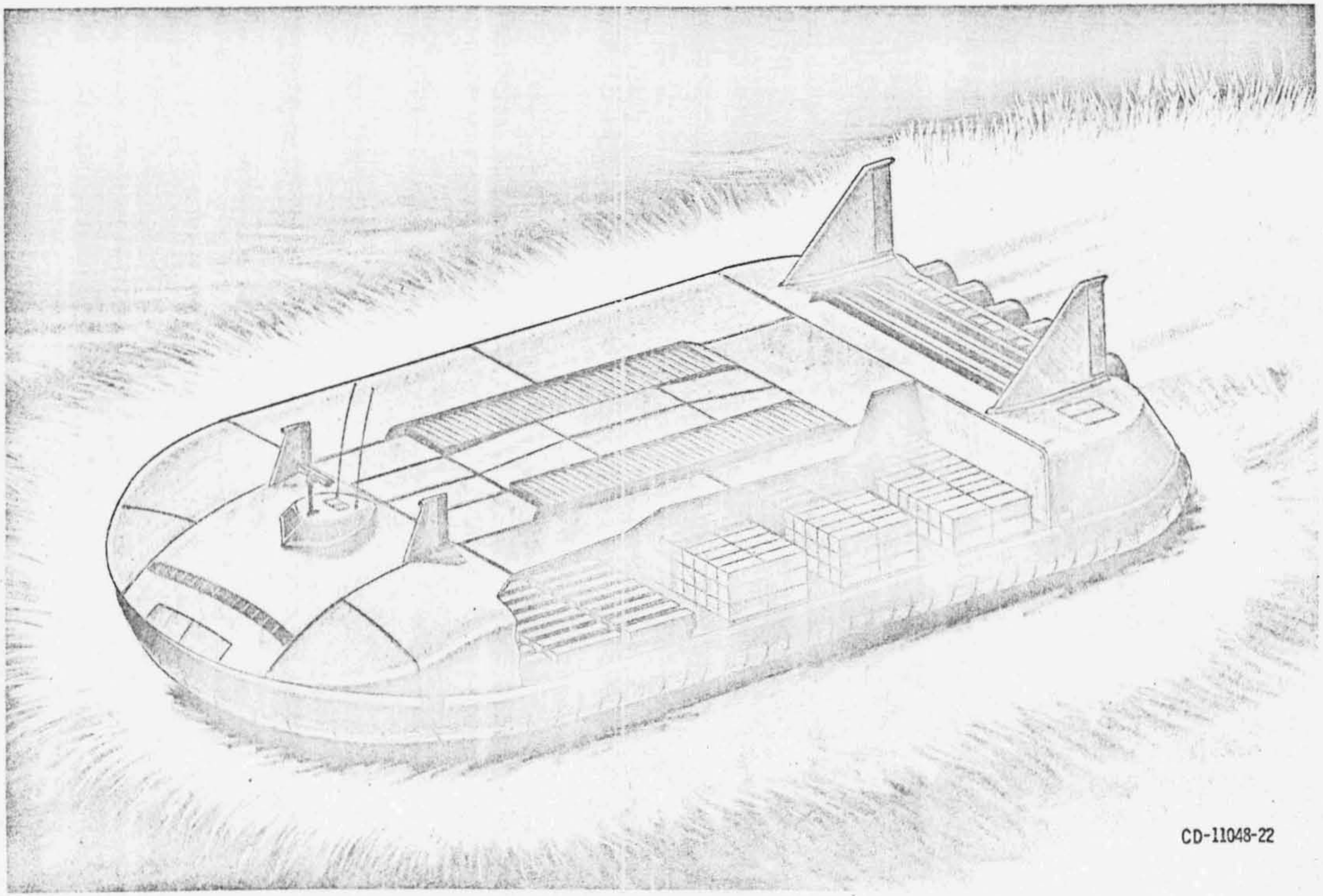

Figure 19

FIGURE 20

This conceptual freighter would be 450 feet long with a beam of 250 feet; the cushion pressure would be 100 pounds per square foot. The skirt would be 25 feet high and the cargo bay 30 feet high, and the cockpit would ride about 65 feet above the surface. Six 13-foot fans of 10 000 hp each would provide the lift; six 25-foot fans of 47 500 hp each would provide the thrust. The maximum thrust would be 466 000 pounds. The total installed effective horsepower of 188 000 would be provided by a 1280-megawatt helium-cooled thermal reactor linked to either gas or steam turbines.

SPECIFICATIONS

DIMENSIONS	LENGTH, 450 FT BEAM, 250 FT SKIRT HEIGHT, 25 FT DAYLIGHT CLEARANCE, 1 FT
POWER	REACTOR, 1280 MW INSTALLED EFFECTIVE POWER, 188 000 HP MAXIMUM THRUST, 466 000 LB L/D, 20 CUSHION PRESSURE, 100 LB/FT^2
WEIGHT	GROSS, 5000 TONS PAYLOAD, 2765 TONS STRUCTURE, 1130 TONS SHIELD, 415 TONS POWERPLANT, 344 TONS CHEMICAL FUEL (RESERVE), 350 TONS

Figure 20

FIGURE 21

This mobile nuclear reactor would be biologically shielded and contained in a manner that would prevent the leakage of radioactivity upon and after impacts at up to 100 knots (the speed of this freighter). The reactor would also be lightweight compared to present mobile (land and ship based) reactors. Conceptual studies of the nuclear airplane indicate that present ship reactor weight could be reduced by at least a factor of ten.

MOBILE NUCLEAR REACTOR CONCEPT

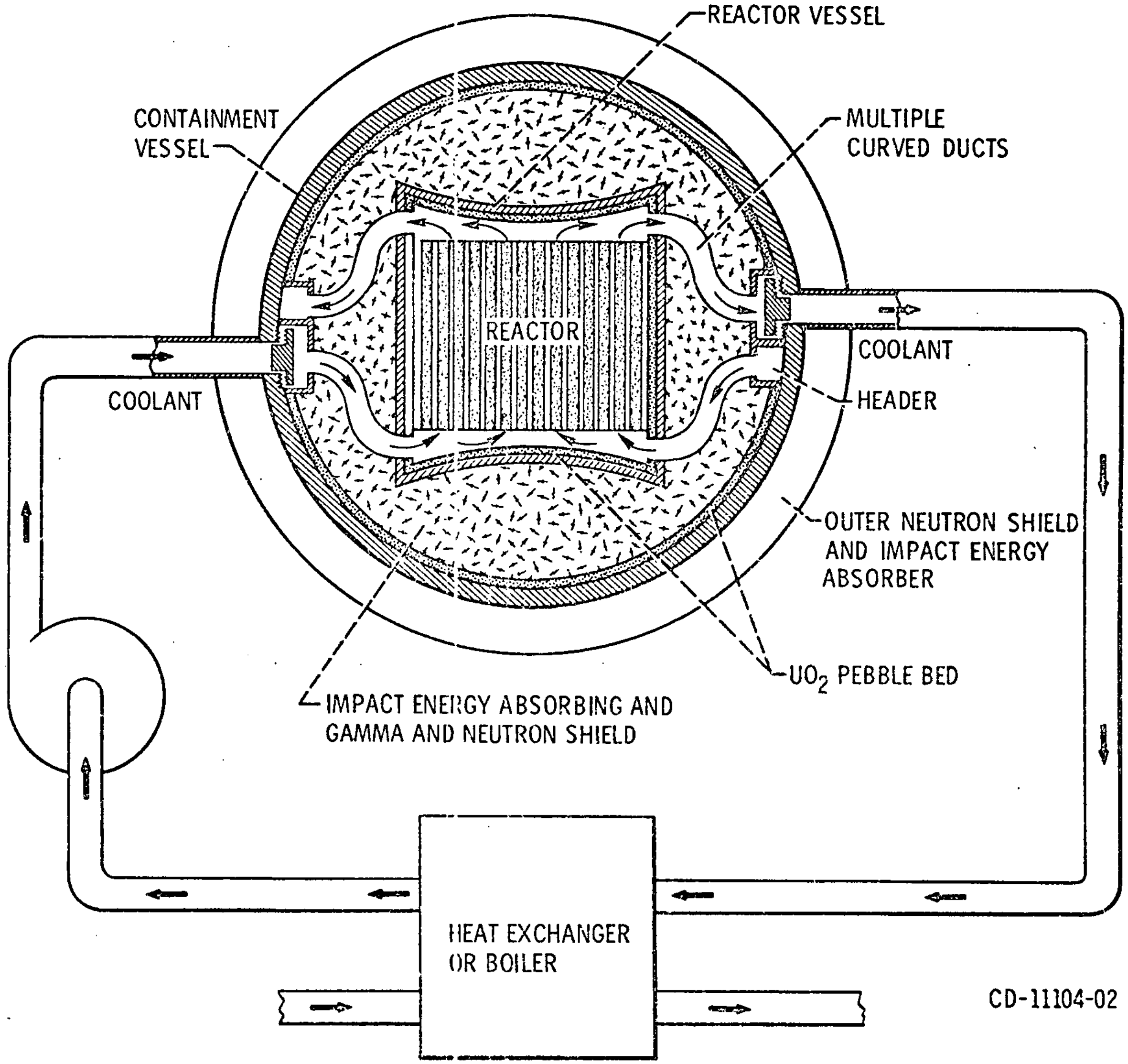

Figure 21

FIGURE 22

Of this freighter's 5000-ton gross weight, more than 2700 tons would be payload. The cargo space is U-shaped; each "arm" is about 350 feet long, 75 feet wide, and 30 feet high. The total cargo volume available is about 1.4 million cubic feet. Assuming an average trailer truck van is 8 feet by 8 feet by 35 feet and weighs 25 tons loaded, this ACV freighter could carry 110 of these vans on the main cargo deck. In fact, these 110 vans would occupy only about 65% of the available deck space. This freighter is well suited to carry low density-high volume cargo such as cars at 6 pounds per cubic foot or mobile homes at 4 pounds per cubic foot.

CARGO SPACE OF ACV FREIGHTER

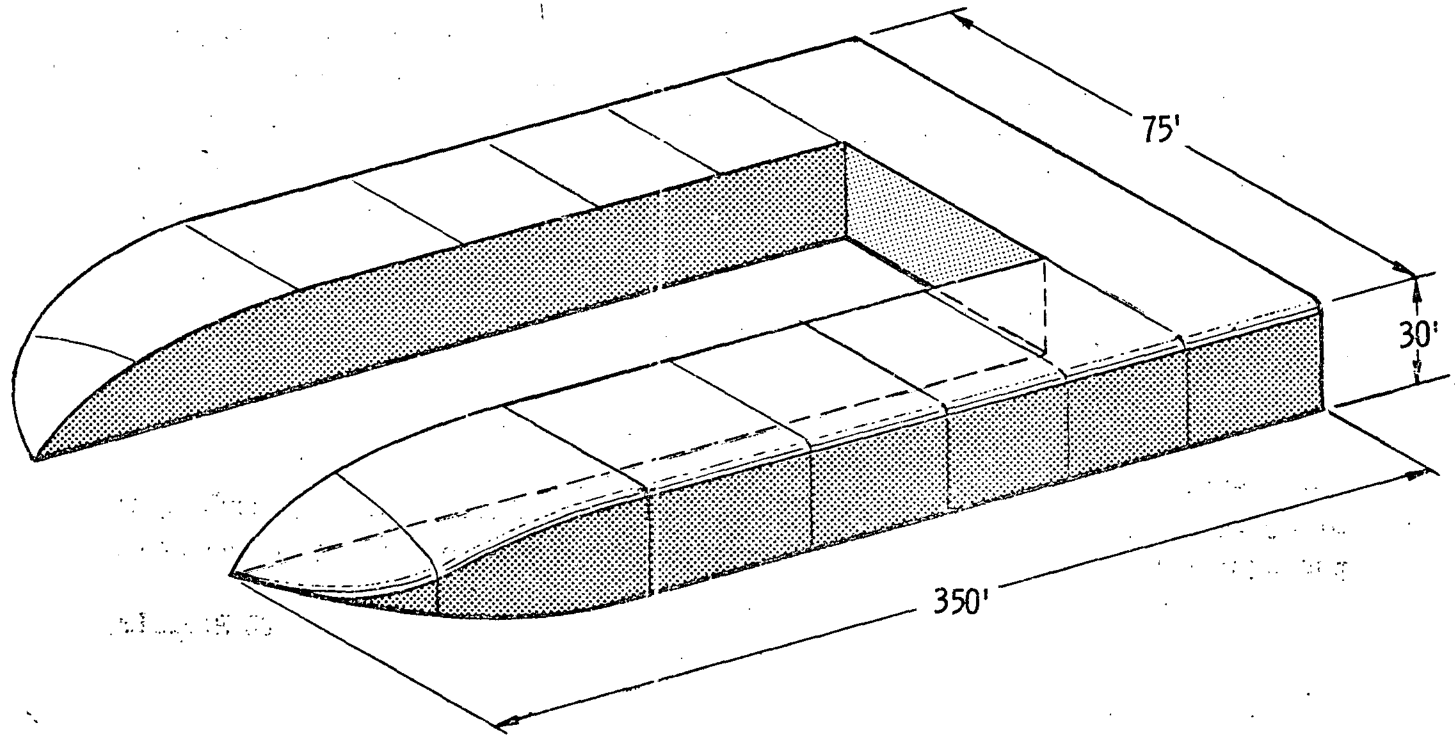

Figure 22

FIGURE 23

The concept of cargo containerization has had a major influence on the economics and techniques of ocean shipping. Using cargo containers of standard size (usually 8 ft by 8 ft by 10, 20, 30, or even 40 ft) sea, and now even air, transportation is being integrated with land transportation to form an intermodal system. The New York Port Authority has predicted that 70% of all containerizable cargo on the North Atlantic trade routes will move in container ships by 1973 and 55% of containerizable cargo will be moved in similar fashion between Japan and the U.S. East Coast. With containers, of course, there are fewer pieces to be handled during loading and unloading the carrier; the cargo is turned around faster. As of 1969 a container ship earned three to four times as much revenue as a comparable break-bulk ship. With ACV transit times much shorter than for ships it will be necessary that ACV cargo be turned around even faster. New cargo transfer techniques such as containerization and "passenger-like scheduling" must be used.

ACV FREIGHTER IN CONTAINERIZED CARGO TRANSFER MODE

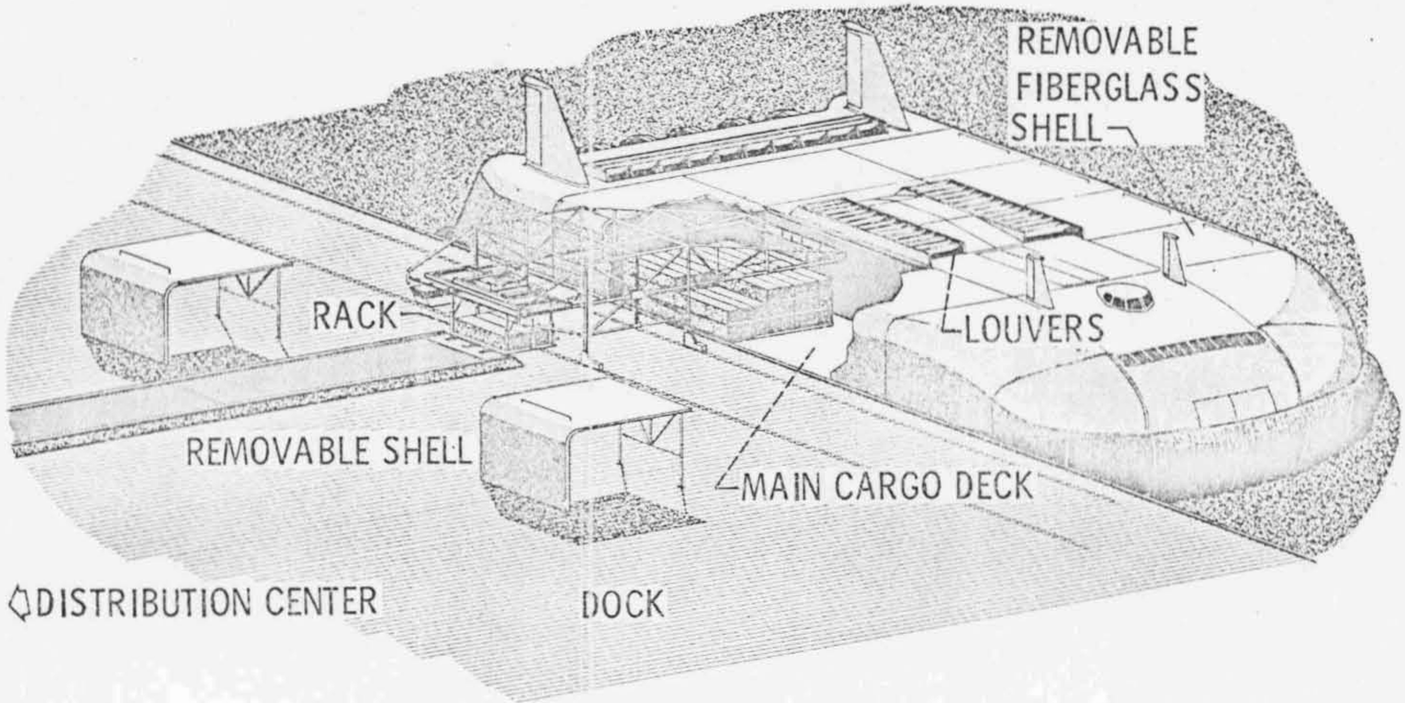

Figure 23

FIGURE 24

In addition to having its cargo transferred by crane or conveyor, this freighter could carry its cargo in a roll-on - roll-off mode - for example, the 110 25-ton trailer truck vans. Containers would be used that are mobile - to be towed or even driven on and off the freighter. Essentially, it would be a step toward rather sophisticated containers that can load and unload themselves. By using two decks this freighter could ferry nearly 500 camping families (with camper or car with tent or trailer) to Europe in a day and a half at a one-way cost of about $300 per family. The ACV could thus act as a transocean highway greatly increasing interchange and hence understanding among cultures.

ACV FRIEGHTER IN ROLL OFF CARGO TRANSFER MODE

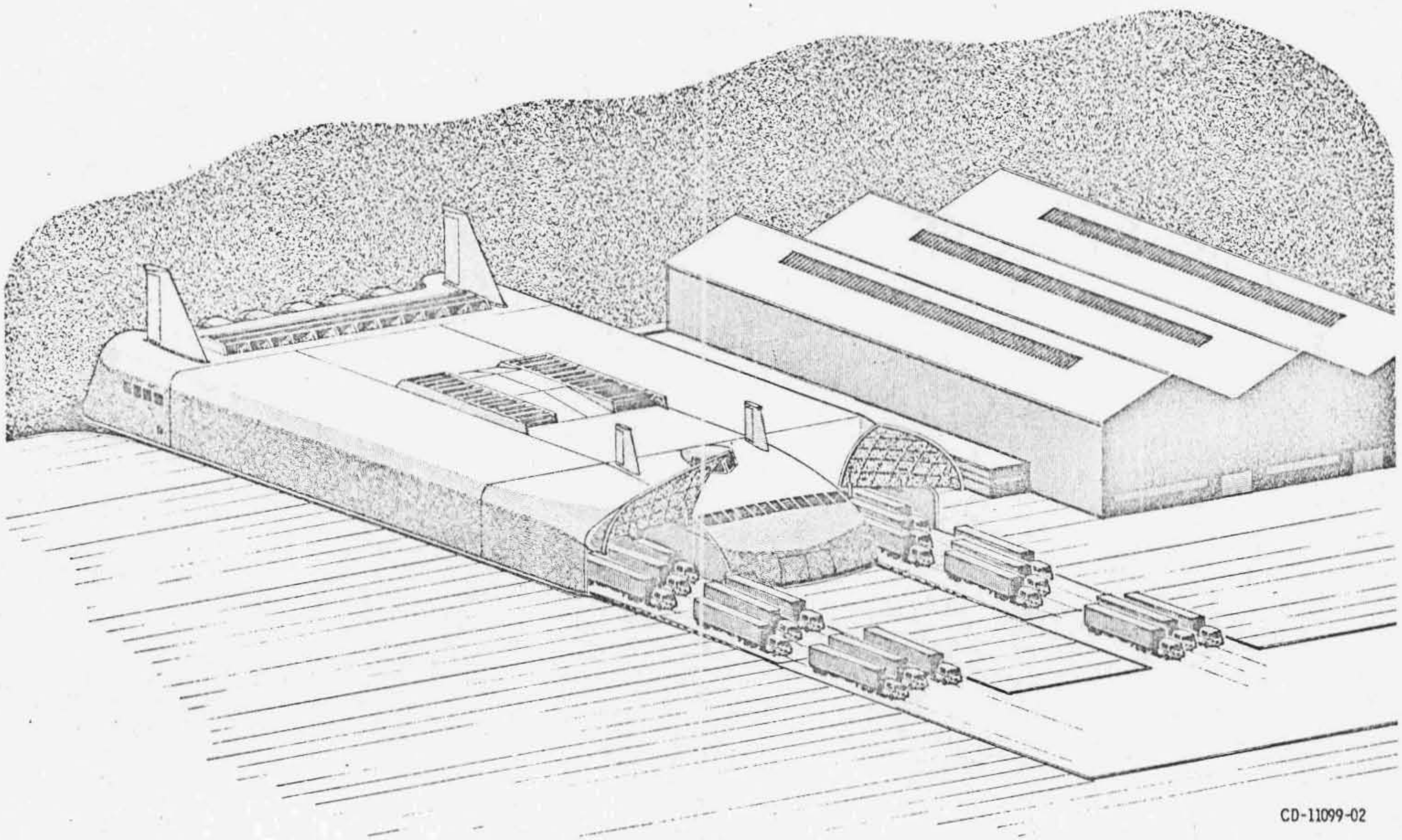

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Figure 24

FIGURE 25

A step toward more complete containerization would be to preload all cargo on large movable docks or pallets already configured to the cargo space of the freighter. This would eliminate the time needed to arrange and stack smaller cargo units and thus further shorten the dock time. These methods of fast cargo transfer (roll-on - roll-off and large preloaded pallets) coupled with the freighter's ocean-going speed could allow expensive inventories to be reduced. Large quantity transatlantic orders of vehicles, machinery, or appliances could be filled within 2 days.

ACV FREIGHTER IN "FORK-LIFT" CARGO TRANSFER MODE

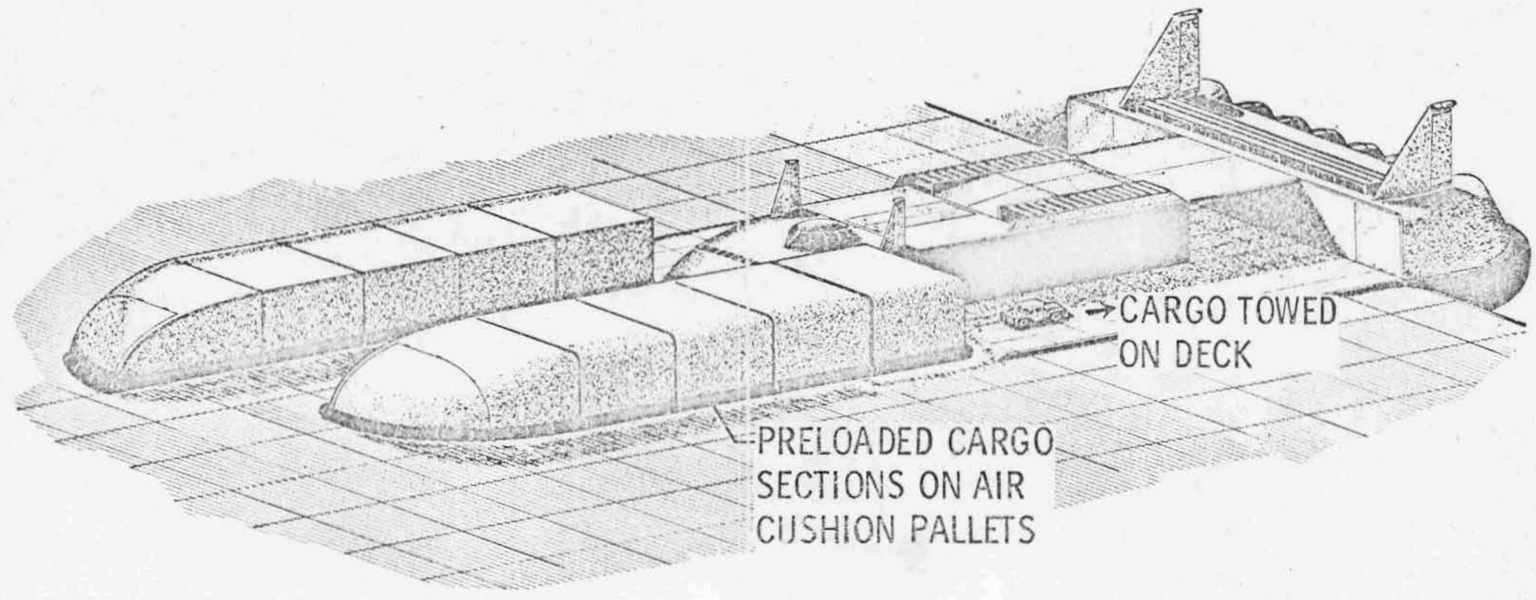

Figure 25

FIGURE 26

This freighter has more than an acre of main deck space. Because the cargo space is about 3 stories high, the freighter could provide about 3 acres of floor space. Coupled with its mobility, it could thus carry and distribute prefabricated housing units such as Habitat. Its speed would allow transportation of emergency housing and medical facilities to coastal disaster areas.

MODULAR HOUSING (HABITAT - EXPO 67)

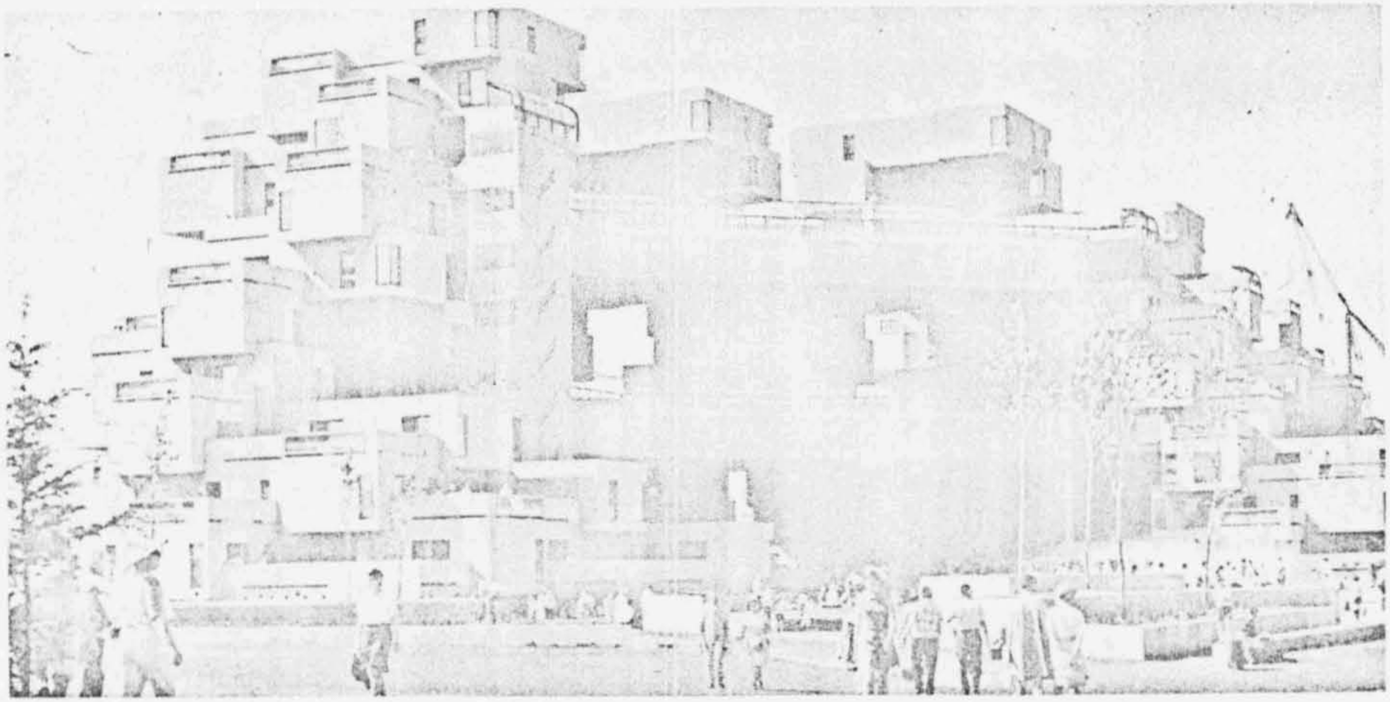

Figure 26

FIGURE 27

But that is not all. It could transport prefabricated and outfitted building units or even become a mobile building unit. A building unit might be a factory, an equipment service center, an educational center, a hospital, barracks, temporary offices, or a field kitchen. In short, it becomes a mobile building that could serve nearly all the functions of land-anchored buildings.

ACV FREIGHTER IN ''MOBILE BUILDING'' MODE

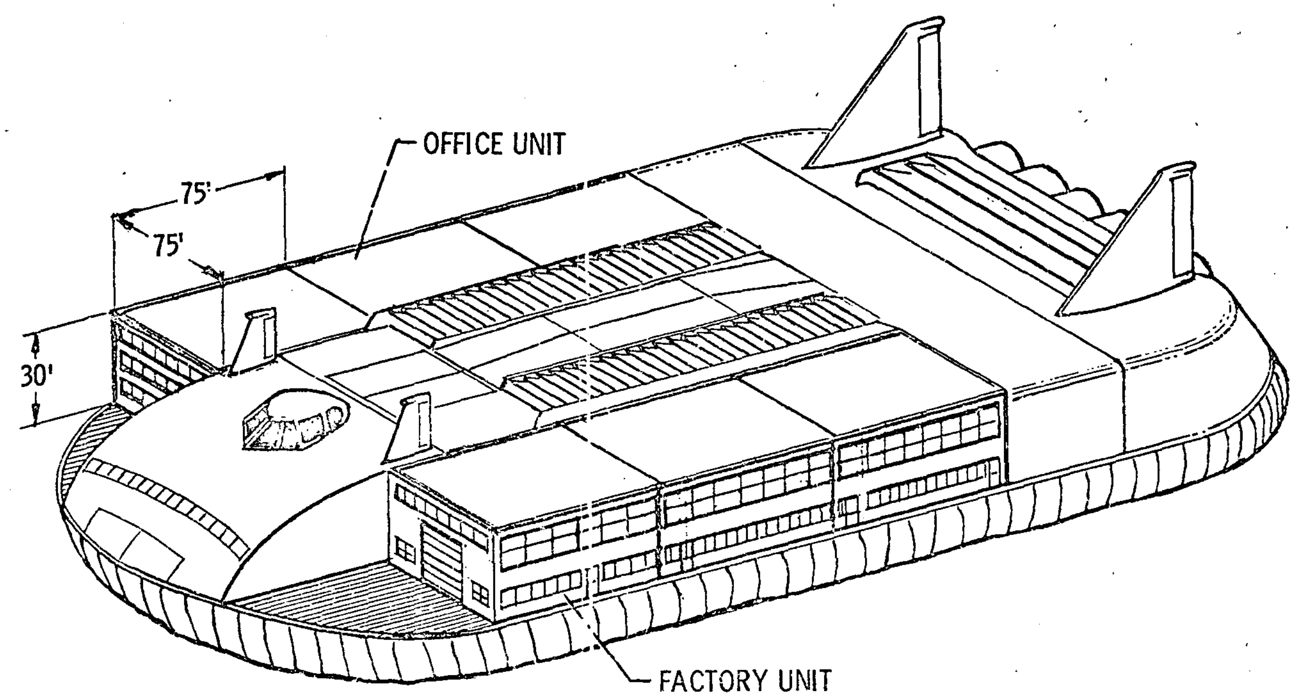

Figure 27

FIGURE 28

In order to fully realize the ACV freighter potential, new cargo terminals must be designed for fast cargo transfer. Automated conveyor systems and containerization would be key features. Cargo flow would, of course, have to be optimized according to the relative cargo volumes and costs of each carrier. The idea of a cargo warehouse will have to be replaced by the idea of a cargo terminal. The terminal must become a scheduling center for cargo much as passenger terminals are now scheduling and connecting centers for "people cargo." In other words, cargo would be moved, not stored.

CARGO FLOW IN CARGO DISTRIBUTION AREA

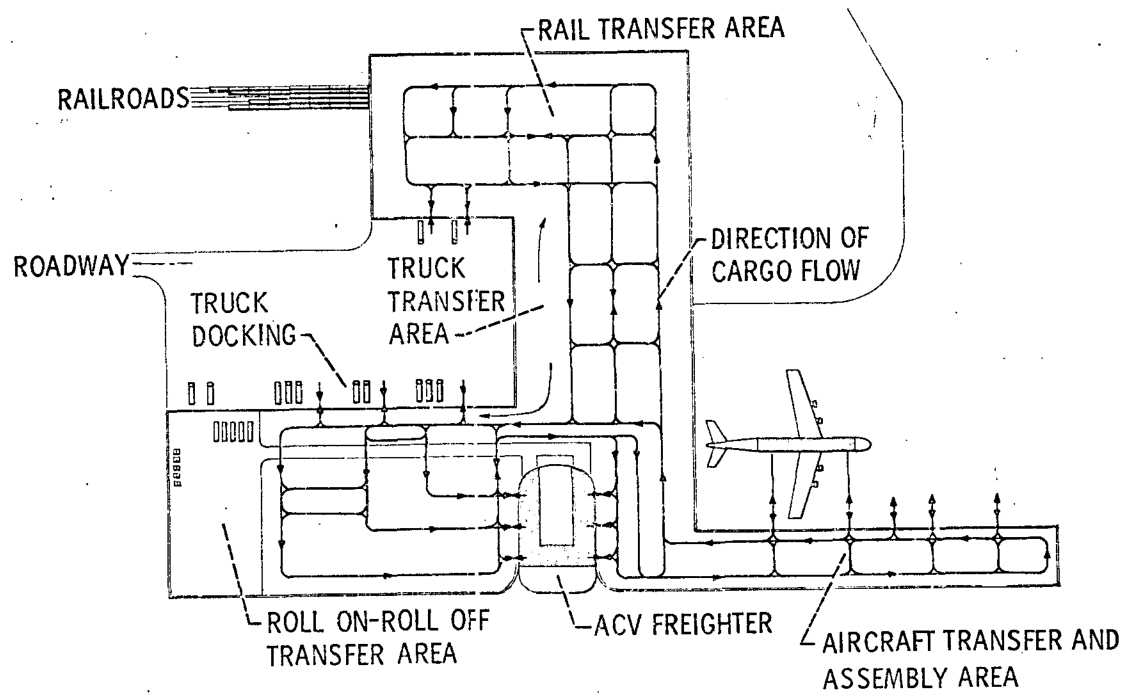

Figure 28

FIGURE 29

The mobility and surface independence of the ACV simplifies the problem of new cargo terminals. New, cheap, and expansive land can be used - land that is away from urban congestion. With this considerable freedom in port location giant cargo terminals can be designed to serve rail, truck, air, and ACV transportation at potentially reduced indirect operating costs.

MODULAR TERMINAL FOR NUCLEAR ACV FREIGHTERS

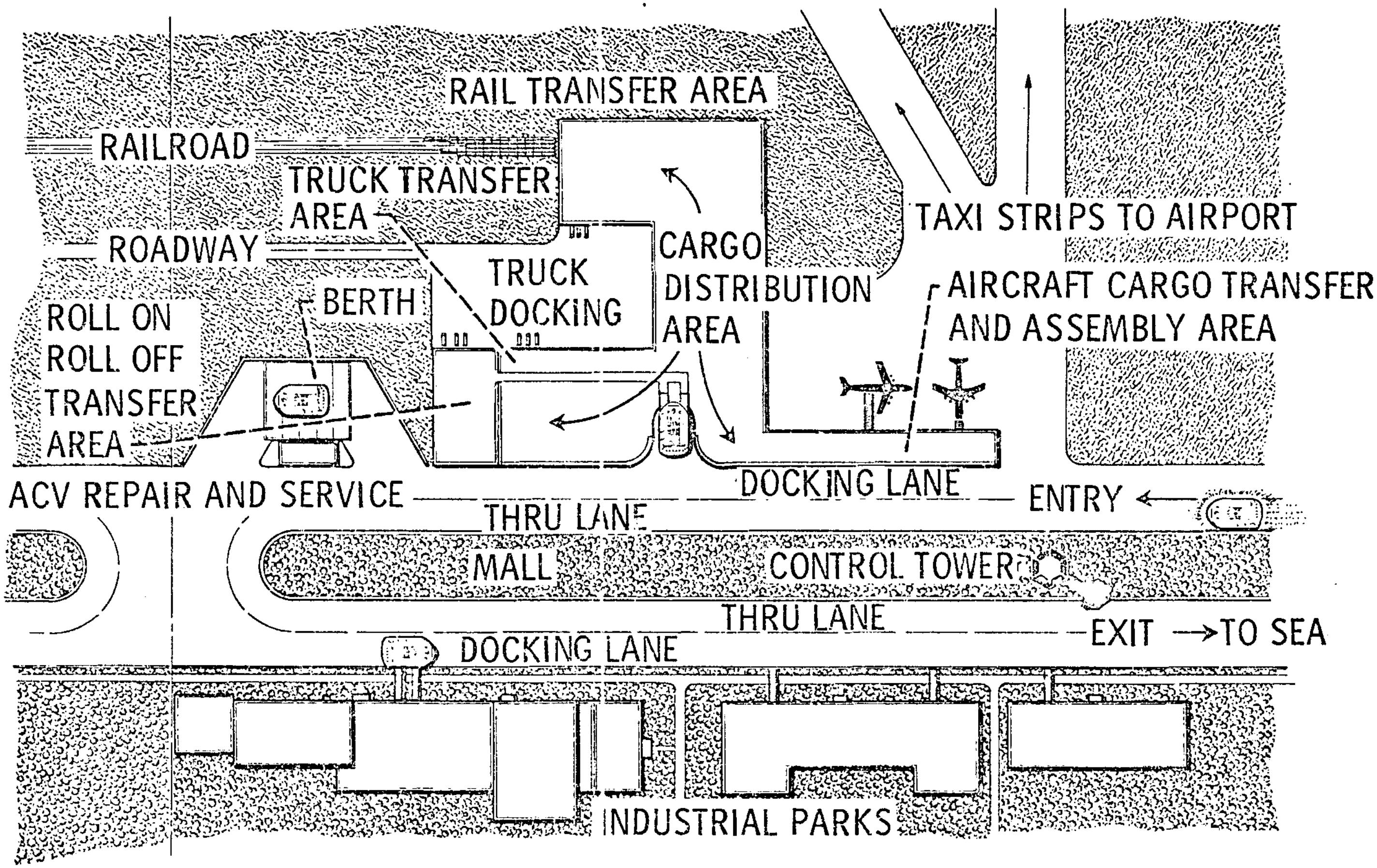

Figure 29

FIGURE 30

The present urban congestion indicates the need for new transportation <u>and</u> population centers for the future. The U.S. population will grow by 50% by the year 2000. New cities will surely be needed if the quality of life is to be improved or even maintained. An ACV commercial cargo transportation system could fit nicely into the design of new cities, particularly the dynamic, growing city concepts. ACV mobility is a powerful freedom which would allow the city-design to fit the terrain - the seashore could be reserved for recreation, nature preserves, or residences; the trade or business sections could be placed several miles inland. However, even coastal land routes may require careful planning because of power lines, buildings, highways, or other obstructions. Fortunately, existing waterways could probably be used for many routes.

CITY-PORT FOR NUCLEAR ACV FREIGHTERS

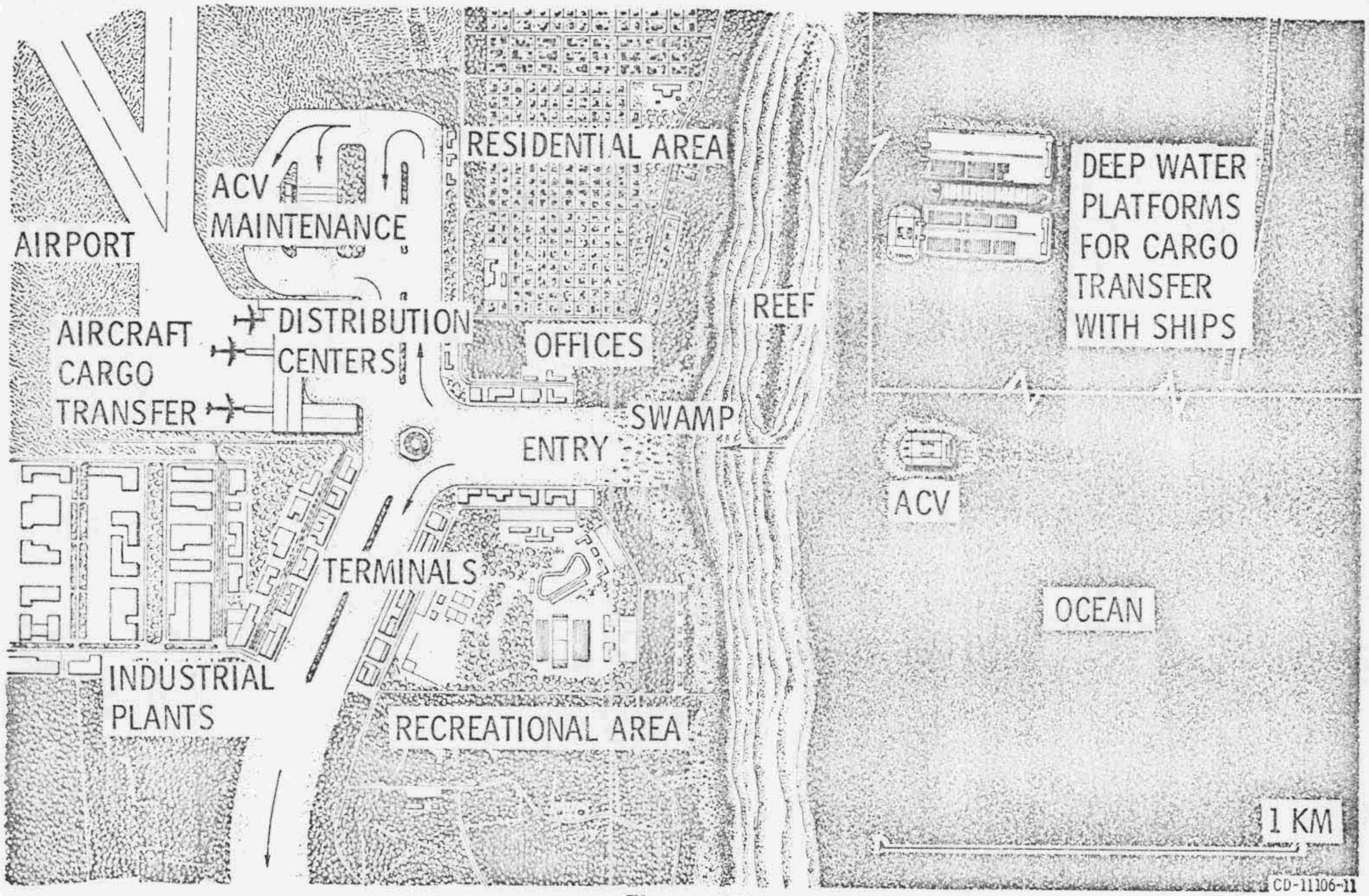

Figure 30

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FIGURE 31

To develop a totally new carrier to compete in an established market will require strong economic incentives. Economic studies of ACV's indicate direct operating costs (those costs necessary for the vehicle operation) that are clearly better than for aircraft and perhaps even competitive with some shipping. It is not so easy to determine the indirect operating costs (those associated with the payload, marketing, and terminals). But the features of the ACV that lead to a freedom in port location do offer impressive opportunities for lower indirect operating costs. Briefly, cheap land and modern building and cargo transfer techniques could be used. Also because rails and highways can be easily located, an ACV port could early become a trade center. And once established, the economic environment thus generated could rapidly reduce the investment risk and entice other industries and entrepreneurs into this new city. Thus the ACV could provide the "economic seed" for new cities just as conventional ships did for the great deep water seaports of the world.

ECONOMIC IMPLICATIONS OF ACV FREIGHTERS

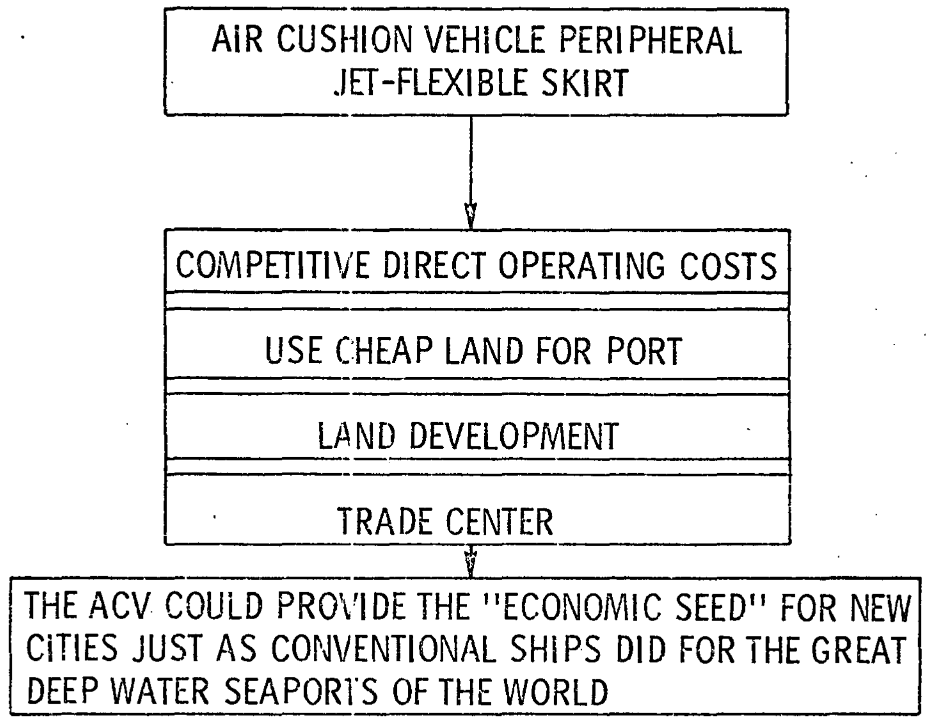

Figure 31

FIGURE 32

It has been little more than a decade since an ACV first carried a man. Now there is broad application and a growing industry for a vehicle that is almost completely independent of the surface over which it travels. And there are studies of large ACV freighters that would conduct commerce among nations. The ACV port offers a widely locatable employment base for both new and existing cities. Because of this, the air cushion vehicle could indeed become a "magic carpet" to escape and relieve the "Baghdads of the Twentieth Century."

GENERAL IMPLICATIONS OF LARGE ACV'S

• COMPETITIVE TRANSOCEAN CARRIER	—	CHEAP AND FAST
• VERSATILE CARRIER	—	SURFACE INDEPENDENT
• NEW INDUSTRY	—	ACV'S
• ECONOMIC SEED FOR NEW CITIES	—	← CHEAP LAND ← EMPLOYMENT BASE ← URBAN RELIEF

Figure 32

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